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COMPARISON OF SOURCE WATERS

FOR

MUNICIPAL DRINKING WATER SUPPLIES

IN ONTARIO

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Abstract

This study uses raw water quality data from the Drinking Water Surveillance Program (DWSP) of the Ministry of Environment (MOE) to classify and compare the characteristics and water quality of different water sources supplying 135 drinking Water Treatment Facilities (WTFs) in Ontario. The physical characteristics, inorganic chemistry and metal content of source waters are extracted from the DWSP database for four years from 1991 to 1994.

The 135 drinking Water Treatment Facilities sampled through the DWSP use as their source water supply: 18 lakes (61 supplies), 24 rivers (42 supplies), and 32 ground water sources (32 supplies). These sources, according to the geographic location and geology of their surrounding environments are divided into two categories: Southern Ontario and the Canadian Shield. The average, minimum, and maximum concentrations of physical, inorganic chemical and metals for each group of source water are calculated, compared and reported in this study. Use of Ontario Drinking Water Objectives (ODWOs) in this study is for comparative purposes only and is not to assess potability of these sources.

Generally, average values in hardness, dissolved solids, alkalinity, major ions, electrical conductivity, Langelier Index, iron, manganese and aluminum in source waters in Southern Ontario are higher than source waters in the Canadian Shield. Overall source waters in Ontario are of the calcium-bicarbonate type with a few exceptions.

The results of this report are intended as an update of the general aspect of source waters and illustrate fluctuations of physical and inorganic chemicals that may affect a wide range of water usage including industrial and commercial supplies. The information may also be useful in design of any future monitoring program and the management planning of water resources in Ontario.

Résumé

Le présent étude a été rédigée à partir des données du Programme de surveillance de la qualité de l'eau potable mis sur pied par le ministère de l'Environnement (MOE). Les données ont été utilisées pour comparer les characteristiques de la qualité de l'eau brute provenant de différentes sources qui alimentent 135 usines de traitement de l'eau en Ontario. Les characteristiques physiques, la teneur en substances chimiques inorganiques et la teneur en métaux de l'eau brute ont été compilés à partir des données recueillies par le Programme sur une période de quatre années, de 1991 à 1994.

L'eau des 135 usines de traitement sélectionnées aux fins de l'étude provient de 18 lacs (61 usines), 24 rivières (42 usines) et 32 sources d'eau souterraine (32 usines). Les sources d'eau brute sont réparties, selon leur lieu géographique et la géologie de leurs milieux, en deux catégories : le sud de l'Ontario et le Bouclier canadien. Le texte, les tableaux et les figures donnent les valeurs moyennes, minimales et maximales des paramètres physiques, de la chimie inorganique et de la concentration des métaux propres ont été calculé, comparé et raporté pour chaque catégorie d'eau brute. Les objectives de qualité de l'eau potable de l'Ontario ont été utilisées pour comparer les sources d'eau brute et non pour évaluer leur potabilité.

En général, les valeurs moyennes relativement à la dureté de l'eau, la quantité de matières dissoutes, l'alcalinité, les ions principaux, la conductivité électrique, l'indice de Langelier, le fer, le manganèse et l'aluminium des sources d'eau brute du sud de l'Ontario sont plus élevées que les valeurs moyennes de l'eau brute du Bouclier canadien. À quelques exceptions près, l'eau brute de l'Ontario se characterise par sa charge en bicarbonate de calcium.

La publication des résultats de cette étude a pour but de faire le point sur l'état général des sources d'eau brute et sur les fluctuations des paramètres physiques et la teneur en substances chimiques inorganiques, ayant une incidence directe sur les utilisateurs d'eau, dont les industries et les entreprises commerciales. Les résultats peuvent également être d'une utilité appréciable pour l'élaboration de nouveaux programmes de surveillance, de gestion et de planification des ressources en eau en Ontario.

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Any opinions expressed are those of the author and do not necessarily represent the position of the Ministry of Environment.

INTRODUCTION

Data from the Drinking Water Surveillance Program (DWSP) on file with the Ministry of Environment (MOE) were used to evaluate and compare the water quality of the source waters that supply 135 Water Treatment Facilities (WTFs) in Ontario that are monitored as part of the DWSP. The purpose of this study is primarily to compare the physical and inorganic chemical characteristics of source waters used by WTFs. Use of Ontario Drinking Water Objectives (ODWOs) in this study is for comparative purposes only and is not to assess the potability of these water sources. The results of this comparison may be of great interest to a wide range of water users including industrial and commercial sectors. It may also be useful in design of any future monitoring program and the management planning of water resources in Ontario.

The study includes :

- compilation and statistical analysis of source water quality in accordance with the surrounding geology,
- differences in physical and inorganic chemicals, ion and metal concentrations between lake, river and ground water, and
- identification of source water types supplying Water Treatment Facilities in Ontario

SOURCES OF INFORMATION

This study made comprehensive use of the DWSP database collected for 135 water treatment facilities in Ontario from 1991 to 1994. In addition, historical reports on geology and hydrogeology of Ontario, digital electronic aquifer mapping data and the Ministry of Environment Water Well Information System (WWIS) were used to assess the raw water quality sources in this study.

Drinking Water Surveillance Program (DWSP)

The DWSP is a monitoring program that monitors drinking water quality at municipal water supply systems and provides immediate, reliable and current information on drinking water quality in Ontario. A major goal of the program is to collect valid water quality data in context with plant operational information at the time of sampling. Three types of samples are taken; one raw water sample at the intake, one treated sample at the WTF before the distribution system and one sample at the distribution system.

Most laboratory analyses are carried out by the Ministry of Environment (MOE), Laboratory Services Branch. Radionuclides are analyzed by the Ministry of Labour.

Ontario Drinking Water Objectives (ODWOs) prescribe standards of quality for treated drinking water objectives in Ontario (MOEE, 1994). Some ODWOs are aesthetic or health-related, while others are operational guidelines established for parameters that need to be controlled to ensure efficient treatment of water. The primary purpose of ODWOs is to protect public health.

APPROACH AND PROCEDURES

Depending on the nature of the source waters and surrounding geology the physical, inorganic chemical characteristics and metal concentrations of source water discussed in this study are classified in six groups: 1) lakes in Southern Ontario 2) lakes in the Canadian Shield, 3) rivers in Southern Ontario, 4) rivers in the Canadian Shield, 5) ground water in Southern Ontario and 6) ground water in the Canadian Shield. Bedrock geology in Southern Ontario consists of sedimentary rocks (dolomite, limestone, sandstone and shale). The Canadian Shield consists of igneous and metamorphic rocks (gneiss, granodiorite, granite, metavolcanic, metasedimentary and intrusive). For more detail on geology of Ontario see Thurston et al. (1991 and 1992).

Figure 1. shows the location of selected DWSP water treatment facilities in Ontario. The name, source, location and population served of WTFs in Ontario is presented in **Tables 1, 2, 3, 4** and **5**.

The chemical/physical parameters in lake, river, and ground water used by the DWSP water treatment facilities in Ontario are presented in **Tables 6, 7, 8, 9** and **10**. The number of plants, average, minimum and maximum values for each parameter in each of the six source water groups are calculated and reported at the end of each of the tables.

The water types for different sources is summarized in **Table 11**. Percentages of ground water types in various bedrock units of Southern Ontario is abstracted from the publication "Hydrogeology of Southern Ontario" (Singer et al. 1997) and presented in **Table 12** of this study.

Tables 13-a, 13-b and 13-c, represent the average metal concentrations in source water of lake, river and ground water in Ontario. **Table 14** summarizes the average concentrations of selected parameters in the source waters in Ontario.

SOURCES OF WATER SUPPLY

Ontario has access to the world's largest body of fresh water for drinking supplies. Over one-fifth of the world's fresh water is contained in the Great Lakes. In Ontario, both surface water (primarily the Great Lakes) and ground water serve as sources for drinking water supply. Surface water provides drinking water to the majority of the population. The total number of municipal drinking water supplies in Ontario is 622, serving a population of approximately nine million. 219 of these supplies rely on surface water and the remaining 403 supplies depend on ground water (MOEE, 1995). Of the 135 water treatment facilities in this study, 61 use lake water, 42 use river water and 32 use ground water.

Water Treatment Facilities Depending On Lakes

Hem (1970) described a lake as a surface outlet that represents a holding and mixing basin for streamflow.

Sixty-one of the water treatment facilities in this study depend on 18 lakes for their source water supply. Of this, 46 water treatment facilities rely on eight lakes in Southern Ontario and 15 water treatment facilities rely on 10 lakes in the Canadian Shield.

Water Treatment Facilities Depending On Rivers

The water carried in streams and rivers is often considered to consist of a base-flow fraction of ground water that infiltrates into the channel and a direct runoff fraction that enters the drainage system during and soon after precipitation periods. The direct runoff has no residence time in the ground water reservoir, except a short contact with soil and vegetation. The base-flow, on the other hand, has a longer residence time in the ground water reservoir containing minerals and therefore, has a higher dissolved-solids content (Hem 1970).

Forty-two water treatment facilities use water from 24 rivers in Ontario. Of this, 27 water treatment facilities rely on 15 rivers in Southern Ontario and 15 WTFs rely on nine rivers in the Canadian Shield.

Water Treatment Facilities Depending On Ground Water

Ground water, an important source of drinking water is also used for irrigation, industrial and commercial use. It provides base-flow water to rivers and streams and maintains many ecosystems valued for fish production, wildlife habitat and recreation.

Thirty-two water treatment facilities in this study use ground water. Of this, 25 water treatment facilities use ground water in Southern Ontario and seven WTFs use ground water in the Canadian Shield.

PHYSICAL AND AGGREGATE PARAMETERS OF SOURCE WATER

Data on hardness, total dissolved solids (TDS), turbidity, Langelier Index, temperature and conductivity collected between 1991 and 1994 were averaged and compiled to evaluate the physical quality of different source waters used by the DWSP water treatment facilities in Ontario.

Hardness

Water hardness is caused by dissolved polyvalent metallic ions, mainly calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate in milligrams per liter. Hardness may be expressed as carbonate (temporary) or non carbonate (permanent) hardness. Carbonate hardness is equal to the total alkalinity of the water that is the sum of carbonate and bicarbonate. The portion of hardness that is greater than total alkalinity is considered non carbonate hardness. Hardness in drinking water can have significant aesthetic and economic effects. On heating, hard water may cause scaling to occur in plumbing fixtures and in hot water appliances, or may result in excessive soap consumption. Soft water, on the other hand, may result in corrosion of water pipes. Although soft water may be good for drinking and washing, but may not be suitable for industrial and commercial purposes.

Hardness is a common characteristic of ground water in most areas of Southern Ontario. The ODWO for hardness is an operational guideline and is set as the aesthetic objective between 80-100 mg/l (as $CaCO_3$). Hardness greater than 200 mg/l is considered poor but can be tolerated; those in excess of 500 mg/l are normally considered unacceptable for drinking water.

Hardness is classified by (Hem 1970) into the following ranges:

Hardness range (mg/L $CaCO_3$)	Description
0 - 60	Soft
61 - 120	Moderately hard
121 - 180	Hard
>180	Very hard

Average hardness in source water used in the DWSP water treatment facilities is presented in **Figure 2**. This figure shows that the lake water in the Canadian Shield has the lowest hardness (38 mg/l as $CaCO_3$) compared to lake water in Southern Ontario (130 mg/l as $CaCO_3$). Similarly, river water and ground water found in the Canadian Shield have lower hardnesses (42 and 111 mg/l as $CaCO_3$ respectively) compared to river water and ground water in Southern Ontario (172 and 305 mg/l as $CaCO_3$ respectively).

Similar results have been shown by Singer et al. (1997). They have indicated that ground water found in sedimentary rocks in Southern Ontario have generally higher average hardnesses ranging from 99 to 1110 mg/l as $CaCO_3$ compared to crystalline rocks found in the Canadian Shield with an average hardness of 250 mg/l as CaCO3. In addition, Wang et al.(1978), in the study of ground water in Northern Ontario, have shown that ground water in sedimentary rocks has a median hardness of 335 mg/l as $CaCO_3$ compared to the ground water found in crystalline rocks and the overburden with 290 and 292 mg/l as $CaCO_3$, respectively.

Total Dissolved Solids (TDS)

Total Dissolved Solids measures the inorganic salts and small amounts of organic matter that are dissolved in water. Water with extremely low TDS may taste flat. High TDS values may result in excessive scaling in pipes, fittings and household appliances. The ODWO sets an objective for TDS at 500 mg/l.

Figure 3 shows that the source water supply systems in Canadian Shield have comparatively lower TDS concentrations than the water sources in Southern Ontario. In the Canadian Shield, lake waters have the lowest average TDS values (41 mg/l). River water and ground water have higher TDS values of 77 and 207 mg/l respectively.

In Southern Ontario, ground water has the highest average TDS value (431mg/l) compared to river water (253 mg/l) and lake water (196 mg/l). Although the average TDS in the ground water of Southern Ontario is higher than all other sources considered in this study, it is still below the ODWO.

The results of Moira River Basin Study by Sibul et al. (1974) confirm the finding of TDS in the source water discussed in **Figure 3**. They concluded that generally, the least mineralized ground water occurs in igneous rock in the northern part of the watershed and the most highly mineralized waters are found in deep limestone in the extreme southern portion of the basin. They concluded also, that lake waters in the Moira River Basin had the lowest mean TDS values compared to streams and ground water.

Turbidity

Turbidity is caused by the presence of fine suspended matter such as clay, silt, colloidal particles, plankton and other microscopic organisms. High turbidity can interfere with both, disinfection of bacteria and viruses and the maintenance of a chlorine residual. Metals can be adsorbed on the suspended particles in turbid waters.

The aesthetic turbidity level in the ODWOs should not exceed 5 Nephlometric Turbidity Unit (NTU).

Analysis of the DWSP data presented in **Figure 4**, shows that ground water in general has lower turbidity than river and lake waters and has its lowest values in the Canadian Shield (0.39 NTU). River water in Southern Ontario exhibits the highest turbidity (17.2 NTU). This would be expected, since river water is generally shallow, fast flowing and changeable resulting in elevated turbidity.

Langelier Index (LI)

The Langelier Index, (Langelier, 1936), was derived in the mid-1930s as an indicator of scaling potential in water distribution systems, water treatment plants and cooling water systems. The details of this method and others are described by Driscoll (1987).

Langelier Index according to the following equation is:

$$\mathbf{LI = pH - pHs}$$

Where **pH** is the measured pH and **pHs** is the pH at which calcite ($CaCO_3$ (S)) would start to precipitate for the given concentrations of calcium and carbonate. The water is at equilibrium when **LI** is zero, over-saturated (scaling occurs) when **LI** is positive, and under-saturated (corrosive or aggressive) when **LI** is negative.

Figure 5 shows that, generally, source waters in the Canadian Shield have lower Langelier Index and therefore have tendencies to be corrosive (under-saturated). The lowest **LI** in Canadian Shield belongs to the lake water (-1.39) whereas, Southern Ontario lake water sources are over-saturated by a factor of 0.6 **LI** and have tendencies to build up scaling potential in the distribution systems,water treatment plants and cooling systems.

Temperature

Temperature is an aesthetic objective for the ODWO. It is desirable that the temperature of drinking water not exceed 15°C. The palatability of water is enhanced by its coolness. A temperature below 15°C will tend to reduce the growth of nuisance organisms and therefore minimize associated taste, odor and corrosion problems within the supply system.

Figure 6 shows that all sources monitored by the DWSP have average temperature values below 15°C. Source waters of lake, river and ground water in the Canadian Shield have lower average temperature than source waters in Southern Ontario.

Conductivity

Conductivity is the ability of a substance to conduct an electrical current. The unit of measuring conductivity in water is micro-mhos per centimeter (μmhos/cm) at 25 degrees Celsius. The conductance measurement provides a general indication of ion concentration or dissolved solids. For most ground waters, the specific conductance multiplied by a factor of 0.55 to 0.75 gives a reasonable estimate of the total dissolved solids (Driscoll).

The conductivity of source waters used in this study is presented in **Figure 7**. This figure shows that the source waters in the Canadian Shield have comparatively lower average conductivity than the source waters in Southern Ontario.

In the Canadian Shield, river and lake waters have lower averages in conductivity values (96 and 105 μmhos/cm respectively) than ground water (302 μmhos/cm). In Southern Ontario, ground water has the higher average conductivity value (654.8 μmhos/cm) compared to river water (391 μmhos/cm) and lake water (299 μmhos/cm).

CHEMICAL PARAMETERS OF SOURCE WATER

Major ion chemistry (cations and anions), alkalinity and pH in the DWSP source waters in Ontario are discussed below.

Major ion chemistry (Cations and Anions)

Statistical analyses of major ions in the different source waters of Ontario are presented in **Figure 8**. The data show that source water in Southern Ontario have higher average cation and anion concentrations than source waters in the Canadian Shield. Average concentrations of calcium, sodium, magnesium, sulphate and nitrate in source waters in Southern Ontario are several times greater than the average concentrations of the same parameters in source waters in the Canadian Shield. Ground water in the Canadian Shield has higher ion concentrations than lakes and rivers in the same terrain.

As indicated earlier, the finding by Sibul et al.(1974) in Moira River Basin, confirms the above results.

Alkalinity

Alkalinity is a measure of the buffering capacity of water or water's ability to neutralize acid. It is produced by dissolved carbonate and bicarbonate ions, but at normal pH levels (6.5-8.5) it is almost entirely due to bicarbonate (HCO_3). The ODWOs set the operational guideline for alkalinity between 30 and 500 mg/l as $CaCO_3$. Waters with low alkalinity will tend to corrode iron and produce "red water," while highly alkaline waters may produce encrustation on service pipes and water heaters.

According to Hem (1970), the concentration of bicarbonate in precipitation is between one and 10 mg/l. Most surface streams contain less than 200 mg/l alkalinity as $CaCO_3$, while ground waters often carry a higher alkalinity. The discrepancy is due to the dissolution of carbonate minerals from soil and rock. Ground water in areas of carbonate rock such as most of Southern Ontario has high alkalinity.

In the DWSP water treatment facilities in Ontario, the average alkalinity of ground water, river water and lake water in Southern Ontario is higher than their equivalent source waters in the Canadian Shield (**Figure 9**).

As previously mentioned, river water, is usually part of ground water (base-flow). Lake water, although consisting mostly of river water, has much more time to equilibrate with the atmosphere during which it loses CO_2 and therefore loses bicarbonate as calcium carbonate precipitates on the lake bottom.

pH

To produce a water that is neither corrosive nor builds up encrustation in pipes and fittings, the recommended ODWO for pH is set between 6.5 and 8.5. At pH levels above 8.5, mineral encrustation and bitter tastes can occur. Corrosion is commonly associated with pH levels below 6.5 and elevated levels of certain undesirable chemical parameters may result in corrosion of specific types of pipes. With pH levels above 8.5 there is also a progressive decrease in the efficiency of chlorine disinfection and alum coagulation.

Figure 10 shows that the average values of pH for all DWSP source waters are within 6.5-8.5. Lake and river water in Southern Ontario have higher pH average values (8.38 and 8.25) than lake and river water in the Canadian Shield (7.61, 7.7). Ground water in Southern Ontario has an average pH of 8.1which is higher than average pH value of ground water in the Canadian Shield (7.87).

TYPE OF THE DWSP SOURCE WATERS IN ONTARIO

Ions or metals in water originate naturally from minerals contained in soil and rock. Ground water, due to its slow movement caused by long flow paths and long contact time with rocks, has characteristically more minerals than surface water. For example, ground water found in dolomite or limestone bedrock is characterized by having more calcium and magnesium carbonate. Similarly, an evaporitic rock or shale formation as the host rock of the aquifer can produce salty and sulphurous water respectively. Chebotarev (1955) described in detail the factors affecting the variation of ground water salinity.

A water chemical study involving major ion analysis at the 135 water supplies using lake water, river water, and ground water in Southern Ontario and the Canadian Shield was conducted. To assist in the interpretation of the data, a specially modified form of trilinear diagram called a Durov plot (Durov 1948), was used. This method of analysis is quite similar to that of Piper (1944).

In the modified version of Durov, a computerized software program converts the concentration of cations and anions from parts per million (ppm) to equivalence per million (epm) and calculates the percent epm, dominant ions, type of water and produces the Durov plots. The results of Durov analysis for lakes, rivers, and ground waters in Southern Ontario and the Canadian Shield are presented below.

SOUTHERN ONTARIO

Durov analysis for source waters from the lakes and rivers in Southern Ontario has resulted in the calcium-bicarbonate type due to the abundance of carbonate rocks in Paleozoic series.(**Figure 11-A** and **11-C**). Ground water consists of two distinct populations; calcium-bicarbonate and magnesium-sulphate type (**Figure 11-E**). The sulphate and magnesium ions in these waters originate from carbonate rocks (dolostone and limestone) of middle Ordovician to middle Devonian of Paleozoic series in Southern Ontario.

THE CANADIAN SHIELD

Lake waters in the Canadian Shield are calcium bicarbonate with a tendency towards sodium and potassium-chloride type. Ramsey Lake supply in Sudbury is identified as having a sodium-chloride type water (**Figure 11-B**). The proximity of this source water treatment facility to the highway using road salt as a de-icing agent may possibly be the source of sodium-chloride (personal communication). Rivers in the Canadian Shield have a calcium bicarbonate type (**Figure 11-D**).

Ground water supplies in the Canadian Shield are almost all calcium bicarbonate types. Since rivers and lakes are supplied with ground water, they generally have the same type of water as calcium-bicarbonate type. Bracebridge (Leader Spring) water supply is identified as a magnesium-chloride water type (**Figure 11-F**).

As it can be seen, the calcium-bicarbonate type of water dominates overall water sources in Ontario. These chemical characteristics of source waters are mainly due to the interaction of ground water with encompassing soil and rocks containing carbonate and bi-carbonate ions. A summary of source water types used by water treatment facilities in Ontario is listed in **Table 11**.

OTHER GROUND WATER QUALITY STUDIES IN ONTARIO

1) Southern Ontario

The results of the Durov plots abstracted from a report by Singer et al. (1997), are presented in **Table 12**. The table is arranged according to lithology and bedrock units in Southern Ontario. The most dominant water types in carbonate rocks in Southern Ontario are calcium-bicarbonate and bicarbonate. Similarly, well water found in the sandstone of the Nepean Formation and the Precambrian rocks have shown calcium-bicarbonate and bicarbonate types of water.

Well water found in shales have a mixture of dominant sodium-potassium-chloride, sodium-potassium-bicarbonate, calcium-bicarbonate and calcium-sulphate-nitrate types of water.

Well water found in carbonate and evaporitic rocks is dominated by calcium-sulphate-nitrate and calcium-bicarbonate type.

2) The Canadian Shield

Ground water studies in northern Ontario (the Canadian Shield) were conducted by Wang et al.(1978). Water from the overburden and crystalline rocks are predominantly of calcium-bicarbonate type. Water from sedimentary rocks vary from a calcium-bicarbonate type in an area near the Precambrian-Paleozoic contact to a sodium-chloride type in the coastal area.

METALS IN THE DWSP SOURCE WATER

The data on average metal concentrations for different sources of raw water used by water treatment plants in Ontario were retrieved from the DWSP database. Statistical analyses of the data consisting of average, minimum and maximum values for each metal in lake, river and ground water sources in Southern Ontario and the Canadian Shield are presented in **Tables 13-a, 13-b** and **13-c.**

Iron and manganese average concentrations in source water are well below the ODWO. Aluminum in river sources of Southern Ontario is above the ODWO (100µ g/L). Strontium in ground water of the Canadian Shield is higher than other sources. **Figure 12** shows the average distribution of strontium, iron, aluminum and manganese in source waters of Ontario.

Iron

The aesthetic ODWO level for iron is set at 0.3 mg/L. At concentrations above 0.3 mg/L, iron can stain laundry and plumbing fixtures and cause undesirable tastes in beverages. The precipitation of excessive iron imparts an objectionable reddish-brown color to the water. Iron may also promote the growth of certain micro-organisms, leading to the deposition of a slimy coat in piping.

Figure 13 shows that in general, the number of sources with high iron contents in Southern Ontario is higher than the number of sources with high iron contents in the Canadian Shield.

Manganese

The ODWOs have set the aesthetic objective for manganese at below 0.05 mg/L. Manganese is generally present in natural surface waters at concentration below 0.05 mg/L. At levels exceeding 0.15 mg/L, manganese stains plumbing fixtures and laundry and causes undesirable tastes in beverages. The presence of manganese in water may lead to the accumulation of microbial growths in the distribution system that could give rise to taste, odor and turbidity problems in the distributed water.

Figure 14 shows that the number of sources with high average manganese concentrations in Southern Ontario is more than the number of sources with high average manganese concentrations in the Canadian Shield.

Aluminum

The ODWOs have set an operational guideline for aluminum at 100 µg/L. **Figure 15** shows that the number of sources of surface waters with higher than the ODWO for aluminum in Southern Ontario is greater than the number of these sources with high aluminum in the Canadian Shield. The concentrations of aluminum in ground water of both Southern Ontario and the Canadian Shield is almost none or well below the ODWO value.

Summary of Physical/Chemical Parameters and Metals in the DWSP water Sources

The summary of average concentrations of physical/chemical parameters and metals in source waters in Ontario used by the DWSP water treatment facilities is reported in **Table 14.**

CONCLUSIONS

Assessment of the available water quality data existing in the DWSP database leads to the following conclusions:

- raw water sources of ground water, rivers and lakes in Southern Ontario have higher average values in **hardnesses, dissolved solids, alkalinity, major ions, conductivity, Langelier Index, iron, manganese** and **aluminum** compared to the same source waters in the Canadian Shield.

- average **Turbidity** in river and lake water sources in Southern Ontario is higher than average turbidity in similar source waters in the Canadian Shield. Ground water in the Canadian Shield has the lowest average turbidity of all other source waters discussed in this study.

- average **pH** values vary between 7and 8.38, the lowest in ground water and the highest in lake and river sources in Southern Ontario.

- average **Temperature** values vary between 4.6 and 14.7 °C with lowest average temperature occurring in ground water and the highest in lake water in Southern Ontario.

- In general, the predominant source water types used by water treatment facilities in Ontario are **calcium-bicarbonate** and **bicarbonate**. However, few source waters are identified as **chloride**, or **magnesium-sulphate-nitrate** type originating from the natural geologic environment.

REFERENCES

Canter L.W., Knox R.C. and Fairchild D.M., 1987 Ground Water Quality Protection. Lewis Publishers, Inc. pp. 3-5.

Chebotarev I.I., 1955 Metamorphism of natural waters in the crust of weathering. Geochemica et Cosmochemica Acta 8. pp 22-48

Driscoll F.G. 1987 Ground water and Wells, Second Edition, p. 454-455. published by Johnson Division, St. Paul, Minnesota 55112.

Durov, C.A. 1948, Natural Waters and graphic representation of their composition. Akad. Nauk. SSSR Doklady, 59, 87-90.

Hem J.D. 1970 Study and interpretation of the chemical characteristics of natural water. Geological Survey Water Supply paper 1473. p 54 (pp 303).

Langelier, W.F., 1936, The analytical control of anti-corrosion water treatment: American Water Works Association Journal, v 28, p. 1500-1521.

MOEE, EMRB, 1995 Drinking Water Monitoring Discussion Paper

MOEE Ontario Drinking Water Objectives revised, 1994, Ontario Ministry of Environment and Energy pp 1-68

MOEE Water Management, Policies Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy (Revised, 1994).

Piper, A.M., 1944. A graphic procedure in the geochemical interpretation of water analyses. Transactions, American Geophysical Union, Vol. 25, pp 914-923.

Sibul U., Goff K. and Choo-Ying A.V. 1974 Water Resources of the Moira River Drainage Basin. Water Resources Report 6 MOE, pp 50-58.

Singer S.N., Cheng C.K. and Scafe M.G. 1997 The Hydrogeology of Southern Ontario MOEE, Monitoring and Reporting Branch, pp. 134.

Thurston, P.C., Williams H.R, Sutcliffe R.H. and Stott G.M. 1991 Geology of Ontario, Special Volume 4, part 1 OGS/MNDM, pp 711.

Thurston, P.C., Williams H.R, Sutcliffe R.H. and Stott G.M. 1992 Geology of Ontario, Special Volume 4, part 2 OGS/MNDM, pp 1525.

Wang K.T. and Chin V.I. 1978 Northern Ontario Water Resources Studies, Ground-water Resources. MOE, Water Resources Report 11b. pp 71-74

TABLES

Table 1. DWSP Lake water treatment facilities name, source, location and population served in southern Ontario

PLANT	SOURCE	UTM			POPULATION SERVED
		ZONE	EASTING	NORTHING	
AJAX WTP	LAKE ONTARIO	17	660200	4853850	105,472
ALEXANDRIA WTP	MILL LAKE/GLENGARRY	18	528741	5017978	3,560
BEAVERTON WTP	LAKE SIMCOE	17	645950	4921250	3,300
BELLE RIVER WTP	LAKE ST CLAIR	17	359250	4684575	13,000
BELLEVILLE WTP	BAY OF QUINTE	18	308550	4890950	36,792
BURLINGTON WSS	LAKE ONTARIO	17	599840	4798520	112,722
CHATHAM WTP	LAKE ERIE	17	401000	4694200	42,000
COBOURG WTP	LAKE ONTARIO	17	728595	4870450	15,000
COLLINGWOOD WTP	GEORGIAN BAY	17	562835	4928970	12,000
DESERONTO WTP	BAY OF QUINTE	18	336770	4895435	2,349
DUNNVILLE (INDUSTRIAL)	LAKE ERIE	17	613500	4743100	
DUNNVILLE WTP	LAKE ERIE	17	613500	4743100	11,300
FORT ERIE (ROSEHILL) WTP	LAKE ERIE	17	664280	4748700	25,000
GODERICH WTP	LAKE HURON	17	441270	4842930	7,500
GRIMSBY WTP	LAKE ONTARIO	17	614804	4784532	23,081
GRIMSBY WTP	LAKE ONTARIO	17	617650	4784450	
HALDIMAND-NORFOLK WSS	LAKE ERIE	17	573450	4737400	4,270
HAMILTON WSS	LAKE ONTARIO	17	600475	4790380	483,913
HARROW-COLCHESTER SOUTH WSS	LAKE ERIE	17	339800	4649510	3,537
KINGSTON WTP	LAKE ONTARIO	18	379990	4896810	80,500
LONDON (LAKE HURON) WSS	LAKE HURON	17	484820	4762620	271,673
METRO TORONTO (F.J. HORGAN)	LAKE ONTARIO	17	647600	4846550	2,333,290
METRO TORONTO (ISLAND) WTP	LAKE ONTARIO	17	630570	4829600	
METRO TORONTO (R. C. HARRIS	LAKE ONTARIO	17	640540	4836260	
METRO TORONTO (R. L. CLARK)	LAKE ONTARIO	17	620540	4826460	
MITCHELLS BAY WTP	LAKE ST CLAIR	17	383950	4702600	350
NAPANEE WTP	LAKE ONTARIO	18	343400	4901020	5,000
OAKVILLE WTP	LAKE ONTARIO	17	608120	4809650	83,214
OSHAWA WSS	LAKE ONTARIO	17	674815	4858655	124,278
OWEN SOUND (R. H. NEATH) WT	GEORGIAN BAY	17	505345	4936815	20,000
PICTON WTP	BAY OF QUINTE	18	329300	4875900	6,000
PORT COLBORNE WTP	LAKE ERIE	17	642890	4749130	15,092
PORT DOVER WSS	LAKE ERIE	17	564530	4736950	4,682
PORT ELGIN WTP	LAKE HURON	17	467415	4920890	6,000
PORT HOPE WTP	LAKE ONTARIO	17	717030	4868585	10,400
PORT ROWAN WTP	LAKE ERIE	17	545345	4717990	1,000
PORT STANLEY WTP	LAKE ERIE	17	481850	4722470	2,356
SOUTH PEEL (LAKEVIEW) WSS	LAKE ONTARIO	17	616300	4824350	700,000
SOUTH PEEL (LORNE PARK) WSS	LAKE ONTARIO	17	612600	4820100	
SOUTHAMPTON WTP	LAKE HURON	16	946730	4940707	3,000
ST THOMAS (ELGIN) WSS	LAKE ERIE	17	483600	4736090	54,182
STONEY POINT (TILBURY NORTH	LAKE ST CLAIR	17	372085	4687140	3,481
TECUMSEH WTP	LAKE ST CLAIR	17	380857	4686875	15,000
TILBURY WTP	LAKE ST CLAIR	18	293100	4886400	2,000
UNION (ESSEX COUNTY) WSS	LAKE ERIE	17	361480	4654460	39,696
WHITBY WTP	LAKE ONTARIO				40,000

Table 2. DWSP Lake water treatment facilities name, source, location and population served in the Canadian Shield

PLANT	SOURCE	UTM			POPULATION SERVED
		ZONE	EASTING	NORTHING	
BRACEBRIDGE WTP	LAKE MUSKOKA	17	628455	4985110	7,000
COCHENOUR WTP	RED LAKE/BRUCE CHANN				800
DRYDEN WTP	LAKE WABIGOON	15	511400	5514100	6,500
GRAVENHURST WTP	LAKE MUSKOKA	17	628000	4979000	8,000
HUNTSVILLE WTP	FAIRY LAKE	17	639740	5021310	6,000
KENORA WTP	LAKE OF THE WOODS	15	390260	5510310	16,000
MADSEN WTP	RUSSET LAKE				350
NORTH BAY WTP	TROUT LAKE	17	622580	5131430	50,000
RED LAKE WTP	RED LAKE				2,000
RED ROCK WTP	LAKE SUPERIOR	16	408600	5422550	1,500
SAULT STE MARIE WTP	LAKE SUPERIOR	16	703300	5154450	85,000
SUDBURY (DAVID ST) WTP	RAMSEY LAKE	17	501270	5147300	95,453
TERRACE BAY WTP	LAKE SUPERIOR	15	927941	5419584	2,600
THUNDER BAY (BARE POINT) WT	LAKE SUPERIOR	16	341200	5371290	102,416
THUNDER BAY (LOCH LOMOND) W	LOCH LOMOND	16	330480	5351430	

Table 3. DWSP River water treatment facilities name, source, location and population served in southern Ontario

		UTM			
PLANT	SOURCE	ZONE	EASTING	NORTHING	POPULATION SERVED
ALVINSTON WTP	SYDENHAM RIVER	17	429700	4740900	700
AMHERSTBURG WSS	DETROIT RIVER	17	325300	4665675	15,951
BRANTFORD WTP	GRAND RIVER/HOMEDALE	17	557290	4776300	75,080
BROCKVILLE WTP	ST LAWRENCE RIVER	18	447600	4938300	21,169
CASSELMAN WTP	SOUTH NATION RIVER	18	492400	5017500	1,498
CAYUGA WTP	GRAND RIVER	17	592690	4755650	1,000
CHARLOTTENBURGH WTP	ST LAWRENCE RIVER	18	528600	4986500	1,080
CORNWALL WTP	ST LAWRENCE RIVER	18	516310	4984255	45,980
DELHI WTP	NORTH CREEK/LEHMAN R	17	539870	4744300	4,100
DRESDEN WTP	SYDENHAM RIVER	17	403860	4715670	2,477
KITCHENER (MANNHEIM) WTP	GRAND RIVER	17	538600	4806375	147,439
LINDSAY WTP	SCOUGOG RIVER	17	681160	4912760	15,000
NIAGARA FALLS WTP	NIAGARA RIVER/WELLAN	17	658770	4769300	67,654
ODESSA WTP	MILLHAVEN CREEK	18	362410	4904200	925
OHSWEKEN WTP	GRAND RIVER	17	881365	5008999	1,500
PERTH WTP	TAY RIVER	18	404070	4971040	6,050
PETERBOROUGH WSS	OTONABEE RIVER	17	714325	4912925	61,301
PLANTAGENET WTP	SOUTH NATION RIVER	18	500400	5042200	876
PRESCOTT WTP	ST LAWRENCE RIVER	18	458750	4949840	4,584
SARNIA (LAMBTON COUNTY) WTP	ST CLAIR RIVER/LAKE	17	384270	4761840	104,162
SMITH FALLS WTP	RIDEAU RIVER	18	419000	4971780	10,684
ST CATHARINES (DE CEW) WSS	WELLAND CANAL	17	641350	4774230	148,251
TRENTON WTP	TRENT RIVER	18	292820	4888230	20,000
WALLACEBURG WTP	ST CLAIR RIVER/CHENA	17	383390	4713920	11,295
WALPOLE ISLAND WTP	ST CLAIR RIVER	17	375550	4718525	1,900
WELLAND WSS	WELLAND CANAL	17	642765	4761580	52,200
WINDSOR WSS	DETROIT RIVER	17	335300	4687900	214,148

Table 4. DWSP River water treatment facilities name, source, location and population served in the Canadian Shield

PLANT	SOURCE	UTM			POPULATION SERVED
		ZONE	EASTING	NORTHING	
ATIKOKAN WTP	ATIKOKAN RIVER	15	604170	5400445	4,442
BEARDMORE WTP	BLACKWATER RIVER	15	864471	5506199	480
CHAPLEAU WTP	CHAPLEAU RIVER	17	320950	5301270	2,450
EAR FALLS WTP	ENGLISH RIVER	15	480420	5600880	1,000
EMO WTP	RAINY RIVER	15	438400	5386420	834
FORT FRANCES WTP	RAINY RIVER	15	473750	5384775	8,673
HAWKESBURY WTP	OTTAWA RIVER	18	529902	5049461	9,666
NIPIGON WTP	NIPIGON RIVER	16	408550	5430100	2,500
OTTAWA (BRITANNIA) WSS	OTTAWA RIVER	18	438812	5024700	544,288
OTTAWA (LEMIEUX ISLAND) WSS	OTTAWA RIVER	18	442800	5029420	
PEMBROKE WTP	OTTAWA RIVER	18	333850	5077850	20,500
RAINY RIVER WTP	RAINY RIVER	15	384770	5396920	1,000
RENFREW WTP	BONNECHERE RIVER	18	367300	5037000	7,914
ROCKLAND WTP	OTTAWA RIVER	18	476050	5043870	5,000
SUDBURY (WANAPITEI) WSS	WANAPITEI RIVER	17	513950	5146650	

Table 5. DWSP Ground water treatment facilities name, location and population served in Ontario

PLANT SOUTHERN ONTARIO	UTM			POPULATION SERVED
	ZONE	EASTING	NORTHING	
AURORA WELL SUPPLY	17	622941	4872800	20,000
BARRIE WELL SUPPLY	17	628000	4979000	55,000
CAMBRIDGE WELL SUPPLY	17	555600	4806300	77,843
DELHI (SPRING SUPPLY)	17	540850	4743400	4,100
DORCHESTER WELL SUPPLY	16	984125	4775861	3,800
ELMIRA WELL SUPPLY	17	536400	4826800	7,063
GUELPH WELL SUPPLY	17	500000	4800000	76,600
KITCHENER WELL SUPPLY	17	538600	4806375	147,439
MANITOUWADGE WELL SUPPLY	16	587534	5442753	3,500
MILTON WELL SUPPLY	17	587370	4833355	23,200
NEWMARKET WELL SUPPLY	17	622838	4878354	42,850
NORWICH WELL SUPPLY				2,000
ORANGEVILLE WELL SUPPLY	17	571685	4860910	14,608
OTTERVILLE WELL SUPPLY	17	532649	4751424	900
OWEN SOUND (SPRING SUPPLY)	17	503490	4930900	20,000
PENETANGUISHENE WELL SUPPLY				6,000
PORT DOVER (SPRING SUPPLY)	17	563160	4737020	4,682
SIMCOE WELL SUPPLY	17	555475	4743150	14,196
STOUFFVILLE WELL SUPPLY	17	638300	4872700	6,700
STRATFORD WELL SUPPLY	17	504052	4801319	26,300
THAMESVILLE WELL SUPPLY	17	420500	4710300	900
TILLSONBURG WELL SUPPLY	17	521790	4743978	12,000
TRENTON (VICTORIA ST PUMPIN	18	293100	4886400	20,000
WATERLOO WELL SUPPLY	17	539098	4812537	63,565
WOODSTOCK WELL SUPPLY	17	520980	4772900	

CANADIAN SHIELD	UTM			POPULATION SERVED
	ZONE	EASTING	NORTHING	
BLEZARD VALLEY WELL SUPPLY	17	511514	5147544	28,000
BRACEBRIDGE (LEADER SPRING)	17	628455	4985110	7,000
CAPREOL WELL SUPPLY	17	511514	5147544	1,498
DOWLING WELL SUPPLY				1,000
GARSON WELL SUPPLY	17	511514	5147544	5,300
MARATHON WELL SUPPLY	16	544500	5395550	2,317
SAULT STE MARIE WELL SUPPLY	16	710350	5154225	85,000

Table 6. Average Lake water chemical/physical parameters in the DWSP water treatment facilities in Southern Ontario

No	PLANT	RAW SOURCE	AVERAGE CATIONS				AVERAGE ANIONS				PARAMETERS							
			Ca	K	Mg	Na	Cl	F	NO_3	SO_4	Alkalinity	Conductivity	Temperature	Hardness	Lang Index	pH	TDS	Turbidity
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l CaCO3	(µmhos/cm)	oC	mg/l CaCO3			mg/l	NTU
1	AJAX WTP	LAKE ONTARIO	38.7	1.5	8.6	13.2	24.6	0.19	0.40	27.5	101	325	8.7	132	0.43	8.28	211	2.61
2	ALEXANDRIA WTP	MILL LAKE/GLENGARRY	43.1	0.7	3.2	4.4	8.3	0.06	0.06	4.3	116	252	10.2	120	0.32	8.05	164	1.26
3	BEAVERTON WTP	LAKE SIMCOE	45.0	2.0	7.0	13.8	24.1	0.09	0.04	20.8	126	352	11.8	141	0.67	8.34	229	1.88
4	BELLE RIVER WTP	LAKE ST CLAIR	39.6	1.8	10.1	8.6	16.2	0.12	1.54	25.4	107	314	11.9	140	0.43	8.26	204	27.05
5	BELLEVILLE WTP	BAY OF QUINTE	42.7	1.3	4.3	6.9	11.8	0.08	0.21	12.3	110	269	10.4	124	0.47	8.23	175	3.63
6	BURLINGTON WSS	LAKE ONTARIO	39.0	1.6	8.5	13.2	24.2	0.14	0.38	27.7	100	323	8.7	133	0.45	8.31	210	1.61
7	CHATHAM WTP	LAKE ERIE	33.2	1.4	8.4	7.6	15.5	0.11	0.29	22.0	92	268	11.1	118	0.29	8.24	174	20.26
8	COBOURG WTP	LAKE ONTARIO	38.7	1.6	8.4	11.9	22.1	0.13	0.34	27.0	100	317	6.8	131	0.40	8.26	207	2.16
9	COLLINGWOOD WTP	GEORGIAN BAY	25.9	0.9	6.7	3.4	5.7	0.10	0.29	15.1	77	200	10.9	92	0.10	8.20	130	0.60
10	DESERONTO WTP	BAY OF QUINTE	40.5	1.3	4.4	6.4	11.9	0.08	0.16	13.0	105	262	11.2	119	0.39	8.19	170	3.64
11	DUNNVILLE (INDUSTRIAL)	LAKE ERIE	36.9	1.6	9.5	10.4	18.5	0.12	0.41	26.6	102	305	11.8	130	0.39	8.26	199	7.55
12	DUNNVILLE WTP	LAKE ERIE	36.2	1.5	9.3	10.5	19.1	0.12	0.38	26.3	99	302	11.5	127	0.40	8.28	197	4.29
13	FORT ERIE (ROSEHILL) WTP	LAKE ERIE	34.3	1.4	8.8	9.0	15.9	0.13	0.29	24.6	96	284	10.2	122	0.33	8.25	185	4.97
14	GODERICH WTP	LAKE HURON	35.5	1.2	10.1	5.8	10.0	0.11	0.92	19.1	107	262	8.7	130	0.43	8.29	172	19.27
15	GRIMSBY WTP	LAKE ONTARIO	36.9	1.5	8.4	11.8	21.9	0.14	0.30	28.1	97	316	14.0	126	0.33	8.22	213	0.60
16	GRIMSBY WTP	LAKE ONTARIO	38.9	1.7	8.8	13.6	25.1	0.1	0.4	28.3	99	328	8.8	133	0.33	8.19	213	7.48
17	HALDIMAND-NORFOLK WSS	LAKE ERIE	35.0	1.5	9.0	9.0	15.8	0.12	0.28	25.0	95	283	11.1	124	0.35	8.27	184	3.02
18	HAMILTON WSS	LAKE ONTARIO	38.8	1.6	8.6	13.0	23.9	0.13	0.37	27.2	100	322	8.6	132	0.41	8.27	209	3.70
19	HARROW-COLCHESTER SOUTH WSS	LAKE ERIE	32.4	1.3	8.1	8.0	16.4	0.09	0.47	18.6	91	264	12.3	114	0.24	8.19	172	24.60
20	KINGSTON WTP	LAKE ONTARIO	38.0	1.5	8.3	11.6	21.4	0.13	0.26	26.1	98	310	9.3	129	0.42	8.29	202	1.09
21	LONDON (LAKE HURON) WSS	LAKE HURON	29.1	1.0	7.7	3.7	6.4	0.09	0.39	16.5	87	221	9.3	105	0.23	8.23	144	3.36
22	METRO TORONTO (F J HORGAN)	LAKE ONTARIO	39.1	1.5	8.4	12.2	22.5	0.14	0.38	26.8	100	319	6.4	132	0.41	8.26	207	1.28
23	METRO TORONTO (ISLAND) WTP	LAKE ONTARIO	39.2	1.5	8.5	12.4	22.6	0.13	0.34	26.8	100	318	9.1	133	0.43	8.28	207	1.16
24	METRO TORONTO (R C HARRIS	LAKE ONTARIO	38.9	1.6	8.5	12.1	22.7	0.13	0.37	27.3	100	318	7.1	132	0.41	8.26	207	1.99
25	METRO TORONTO (R L CLARK)	LAKE ONTARIO	38.9	1.5	8.5	12.9	23.7	0.12	0.39	27.3	101	323	5.8	132	0.43	8.28	210	2.09
26	MITCHELLS BAY WTP	LAKE ST CLAIR	37.8	1.6	10.0	7.1	14.4	0.11	1.14	26.2	104	297	14.7	136	0.52	8.41	193	6.84
27	NAPANEE WTP	LAKE ONTARIO	38.2	1.5	7.9	11.1	20.5	0.12	0.24	24.5	100	304	10.5	128	0.41	8.28	197	1.01
28	OAKVILLE WTP	LAKE ONTARIO	39.4	1.6	8.8	13.3	24.7	0.14	0.40	27.0	102	329	9.4	134	0.43	8.28	214	3.50
29	OSHAWA WSS	LAKE ONTARIO	39.0	1.5	8.5	12.4	22.9	0.13	0.37	27.0	101	320	6.0	132	0.42	8.27	208	2.12
30	OWEN SOUND (R H NEATH) WT	GEORGIAN BAY	28.4	0.9	7.6	4.4	7.2	0.08	0.33	15.3	86	219	8.3	102	0.19	8.21	139	1.43
31	PICTON WTP	BAY OF QUINTE	40.5	1.5	5.8	8.5	15.5	0.14	0.20	19.5	104	287	10.5	125	0.38	8.18	186	3.47
32	PORT COLBORNE WTP	LAKE ERIE	35.5	1.5	9.0	9.5	16.1	0.12	0.31	25.7	97	288	11.2	126	0.38	8.29	187	4.60
33	PORT DOVER WSS	LAKE ERIE	36.7	1.5	9.0	9.0	17.1	0.13	0.35	25.4	101	292	10.3	128	0.41	8.28	321	35.95
34	PORT ELGIN WTP	LAKE HURON	29.6	1.0	8.2	3.8	6.6	0.09	0.38	17.2	91	229	8.4	108	0.26	8.25	149	4.13
35	PORT HOPE WTP	LAKE ONTARIO	38.6	1.5	8.4	11.9	22.2	0.12	0.33	17.2	100	317	8.7	131	0.45	8.31	206	4.43
36	PORT ROWAN WTP	LAKE ERIE	52.7	2.2	11.7	7.8	15.6	0.12	0.89	26.6	142	378	11.9	177	0.59	8.21	245	5.14
37	PORT STANLEY WTP	LAKE ERIE	34.5	1.8	8.9	8.2	15.4	0.12	0.33	35.5	98	275	11.7	123	0.33	8.24	179	19.05
38	SOUTH PEEL (LAKEVIEW) WSS	LAKE ONTARIO	39.0	1.6	8.7	14.2	25.8	0.14	0.40	11.2	100	328	9.4	133	0.42	8.27	211	1.50
39	SOUTH PEEL (LORNE PARK) WSS	LAKE ONTARIO	39.3	1.6	8.7	13.1	24.2	0.13	0.42	27.3	102	327	9.8	134	0.42	8.26	212	3.83
40	SOUTHAMPTON WTP	LAKE HURON	35.2	1.1	10.3	4.2	7.9	0.09	0.49	26.9	107	268	9.5	130	0.37	8.27	185	2.71
41	ST THOMAS (ELGIN) WSS	LAKE ERIE	34.3	1.7	8.8	8.2	14.7	0.13	0.31	26.8	97	272	10.0	121	0.33	8.24	176	3.70
42	STONEY POINT (TILBURY NORTH	LAKE ST CLAIR	41.3	1.8	9.9	8.0	15.5	0.12	1.72	22.8	109	315	12.7	144	0.50	8.26	204	74.98
43	TECUMSEH WTP	LAKE ST CLAIR	52.3	2.6	12.3	13.8	26.5	0.15	2.71	5.9	137	414	11.7	181	0.62	8.29	169	0.50
44	TILBURY WTP	LAKE ST CLAIR	68.6	1.8	10.1	25.2	43.8	0.06	0.98	31.7	185	518	11.1	213	0.93	8.31	268	32.89
45	UNION (ESSEX COUNTY) WSS	LAKE ERIE	32.2	1.2	8.1	7.9	16.1	0.10	0.51	11.4	90	263	11.6	114	0.25	8.22	171	2.92
46	WHITBY WTP	LAKE ONTARIO	38.0	1.5	8.5	12.0	21.8	0.15	0.37	27.0	99	318	5.8	130	0.38	8.27	207	3.07
		NUMBER OF PLANTS	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
		AVERAGE	38.4	1.7	8.6	10.0	18.2	0.33	0.71	22.6	103	299	10.0	130	0.62	8.38	196	8.32
		MINIMUM	25.9	0.7	3.2	3.4	5.7	0.06	0.04	4.3	59	174	5.8	92	0.10	8.05	130	0.50
		MAXIMUM	68.6	10.6	14.1	25.2	43.8	9.8	9.9	35.5	185	518	14.7	213	9.89	13.82	321	74.98

Table 7. Average Lake water chemical/physical parameters in DWSP water treatment facilities in the Canadian Shield

No	PLANT	SOURCE	AVERAGE CATIONS				AVERAGE ANIONS				PARAMETERS							
			Ca mg/l	K mg/l	Mg mg/l	Na mg/l	Cl mg/l	F mg/l	NO_3 mg/l	SO_4 mg/l	Alkalinity mg/l $CaCO_3$	Conductivity µmhos/cm	T °C	Hardness mg/l $CaCO_3$	Lang. Index	pH	TDS mg/l	Turbidity NTU
1	BRACEBRIDGE WTP	LAKE MUSKOKA	4.0	0.6	1.1	3.4	4.8	0.05	0.23	7.5	7	52	6.5	14	-2.90	7.01	22	0.59
2	COCHENOUR WTP	RED LAKE/BRUCE CHANN	7.7	0.7	2.2	1.4	1.0	0.07	0.05	3.0	26	62	9.9	28	-1.43	7.61	16	0.92
3	DRYDEN WTP	LAKE WABIGOON	15.8	1.0	3.0	2.3	2.2	0.05	0.04	3.1	50	120	8.7	52	-0.56	7.91	28	15.34
4	GRAVENHURST WTP	LAKE MUSKOKA	4.0	0.6	1.0	3.5	4.7	0.04	0.23	7.8	7	54	6.9	14	-2.90	7.01	22	0.77
5	HUNTSVILLE WTP	FAIRY LAKE	3.4	0.6	1.0	3.4	4.3	0.05	0.22	7.4	7	54	9.4	13	-3.04	6.93	20	1.68
6	KENORA WTP	LAKE OF THE WOODS	14.4	1.0	4.6	3.2	3.7	0.06	0.08	5.0	50	121	9.4	55	-0.66	7.85	32	2.03
7	MADSEN WTP	RUSSET LAKE	13.6	1.6	3.2	3.3	4.6	0.08	0.04	12.8	35	116	9.6	47	-1.00	7.69	39	0.73
8	NORTH BAY WTP	TROUT LAKE	6.1	1.2	1.7	9.2	14.9	0.10	0.25	8.4	13	101	4.8	22	-2.21	7.27	42	0.51
9	RED LAKE WTP	RED LAKE	7.6	0.8	2.1	1.4	1.6	0.08	0.05	5.2	24	63	9.2	27	-1.48	7.62	19	6.14
10	RED ROCK WTP	LAKE SUPERIOR	23.5	0.6	4.2	1.6	1.4	0.04	0.09	3.3	75	152	8.1	76	-0.04	8.10	35	0.73
11	SAULT STE MARIE WTP	LAKE SUPERIOR	14.0	0.5	2.8	1.4	1.3	0.03	0.33	16.3	44	99	6.0	47	-0.58	7.99	37	3.74
12	SUDBURY (DAVID ST) WTP	RAMSEY LAKE	16.0	1.6	4.8	35.8	61.6	0.10	0.10	24.0	29	322	7.2	60	-1.13	7.64	144	10.53
13	TERRACE BAY WTP	LAKE SUPERIOR	14.0	0.5	2.9	1.5	1.8	0.04	0.40	19.4	44	99	6.4	47	-0.63	7.95	41	11.60
14	THUNDER BAY (BARE POINT) WT	LAKE SUPERIOR	14.0	0.5	2.9	1.7	1.8	0.04	0.32	3.6	45	102	7.5	47	-0.63	7.94	25	0.47
15	THUNDER BAY (LOCH LOMOND) W	LOCH LOMOND	6.0	0.5	2.5	1.1	0.4	0.02	0.07	3.8	21	58	6.2	25	-1.64	7.59	14	0.78
		Number of Samples	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		Average	10.9	0.8	2.7	4.9	7.3	0.06	0.17	8.7	32	105	7.7	38	-1.39	7.61	36	3.77
		Minimum	3.4	0.5	1.0	1.1	0.4	0.02	0.04	3.0	7	52	4.8	13	-3.04	6.93	14	0.47
		Maximum	23.5	1.6	4.8	35.8	61.6	0.10	0.40	24.0	75	322	9.9	76	-0.04	8.10	144	15.34

Table 8. Average River water chemical/physical parameters in the DWSP water treatment facilities in Southern Ontario

No	PLANT	RAW SOURCE	AVERAGE CATIONS				AVERAGE ANIONS				PARAMETERS							
			Ca	K	Mg	Na	Cl	F	NO_3	SO_4	Alkalinity	Conductivity	Temperature	Hardness	Lang. Index	pH	TDS	Turbidity
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	(mg/l $CaCO_3$)	(µmhos/cm)	°C	(mg/l $CaCO_3$)			(mg/l)	NTU
1	ALVINSTON WTP	SYDENHAM RIVER	86.6	3.5	16.7	12.2	27.3	0.1	4.48	51.52	212	581	12.7	285	1.13	8.34	378	98.92
2	AMHERSTBURG WSS	DETROIT RIVER	31.8	1.3	8.3	7.2	12.8	0.1	0.67	19.66	91	256	13.0	113	0.23	8.19	166	18.87
3	BRANTFORD WTP	GRAND RIVER/HOMEDALE	79.5	3.3	22.8	45.6	78.4	0.1	3.03	68.16	213	758	12.1	289	1.12	8.39	489	14.04
4	BROCKVILLE WTP	ST LAWRENCE RIVER	37.7	1.5	8.3	11.5	21.4	0.1	0.25	25.90	97	307	10.0	128	0.37	8.26	199	1.02
5	CASSELMAN WTP	SOUTH NATION RIVER	67.1	3.5	21.5	20.3	36.1	0.1	1.12	53.15	202	571	11.1	253	0.93	8.29	371	17.70
6	CAYUGA WTP	GRAND RIVER	89.6	3.6	24.9	37.5	61.8	0.2	2.76	103.17	210	760	10.9	326	1.15	8.37	512	33.86
7	CHARLOTTENBURGH WTP	ST LAWRENCE RIVER	37.2	1.7	8.3	12.0	21.8	0.1	0.25	26.64	97	308	11.1	127	0.37	8.25	195	1.60
8	CORNWALL WTP	ST LAWRENCE RIVER	36.9	1.5	8.3	11.6	21.3	0.1	0.26	25.85	97	304	10.7	126	0.37	8.25	197	1.39
9	DELHI WTP	NORTH CREEK/LEHMAN R	85.1	1.8	14.1	8.0	17.1	0.1	2.10	61.86	199	531	8.3	271	1.12	8.36	345	3.05
10	DRESDEN WTP	SYDENHAM RIVER	87.0	3.7	17.2	12.5	29.1	0.1	4.75	57.39	210	596	12.9	280	1.08	8.31	388	35.82
11	KITCHENER (MANNHEIM) WTP	GRAND RIVER	73.4	3.2	20.9	32.8	55.2	0.1	2.73	34.66	225	647	10.6	270	1.08	8.35	415	20.05
12	LINDSAY WTP	SCOUGOG RIVER	61.8	2.0	8.8	10.1	20.7	0.1	0.45	18.49	166	403	10.8	191	0.79	8.23	255	7.56
13	NIAGARA FALLS WTP	NIAGARA RIVER/WELLAN	33.6	1.4	8.7	8.7	15.7	0.1	0.26	24.56	94	278	10.1	120	0.33	8.26	175	1.61
14	ODESSA WTP	MILLHAVEN CREEK	46.7	1.6	10.3	9.9	18.8	0.1	0.09	13.08	144	348	11.0	159	0.56	8.19	226	1.88
15	OHSWEKEN WTP	GRAND RIVER	83.3	3.2	22.2	35.5	60.6	0.1	3.10	64.15	223	707	8.2	299	1.16	8.37	454	31.50
16	PERTH WTP	TAY RIVER	22.6	1.2	5.3	2.9	4.6	0.1	0.04	8.08	71	168	11.4	78	-0.11	8.08	109	1.66
17	PETERBOROUGH WSS	OTONABEE RIVER	31.9	1.0	3.4	4.4	7.8	0.1	0.10	10.10	83	205	10.4	94	0.15	8.14	133	1.15
18	PLANTAGENET WTP	SOUTH NATION RIVER	55.2	4.2	16.4	29.3	41.3	0.1	1.27	36.75	176	522	11.0	205	0.68	8.16	340	85.25
19	PRESCOTT WTP	ST LAWRENCE RIVER	37.5	1.5	8.4	11.7	21.5	0.1	0.27	22.83	97	308	9.9	128	0.37	8.24	200	44.61
20	SARNIA (LAMBTON COUNTY) WTP	ST CLAIR RIVER/LAKE	28.4	1.0	7.7	4.0	7.0	0.1	0.36	9.00	85	220	9.5	102	0.17	8.20	143	4.61
21	SMITH FALLS WTP	RIDEAU RIVER	30.3	1.4	7.4	4.7	8.0	0.1	0.06	3.58	94	228	11.2	106	0.16	8.13	148	1.12
22	ST CATHARINES (DE CEW) WSS	WELLAND CANAL	35.1	1.5	9.0	9.7	17.1	0.1	0.31	21.47	96	293	13.8	125	0.34	8.25	191	3.93
23	TRENTON WTP	TRENT RIVER	40.3	1.2	4.1	5.7	9.7	0.1	0.15	22.21	106	254	13.9	118	0.45	8.25	165	3.69
24	WALLACEBURG WTP	ST CLAIR RIVER/CHENA	29.4	1.1	7.8	5.3	9.3	0.1	0.79	19.02	86	234	10.7	105	0.20	8.23	152	17.18
25	WALPOLE ISLAND WTP	ST CLAIR RIVER	28.1	1.0	7.6	5.1	8.3	0.1	0.35	17.57	85	224	9.7	101	0.18	8.23	146	4.89
26	WELLAND WSS	WELLAND CANAL	35.4	1.5	9.1	10.0	16.9	0.1	0.31	16.46	96	293	11.2	126	0.38	8.29	191	5.62
27	WINDSOR WSS	DETROIT RIVER	31.3	1.3	8.2	5.6	9.8	0.1	0.61	26.55	91	245	12.8	112	0.24	8.21	159	0.98
		NUMBER OF PLANTS	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
		AVERAGE	49.7	2.0	11.7	13.8	24.4	0.1	1.15	31.92	135	391	11.1	172	0.56	8.25	253	17.17
		MINIMUM	22.6	1.0	3.4	2.9	4.6	0.1	0.04	3.58	71	168	8.2	78	-0.11	8.08	109	0.98
		MAXIMUM	89.6	4.2	24.9	45.6	78.4	0.2	4.75	103.17	225	760	13.9	326	1.16	8.39	512	98.92

Table 9. Average River water chemical/physical parameters in the DWSP water treatment facilities in the

Canadian Shield

No	PLANT	RAW SOURCE	AVERAGE CATIONS				AVERAGE ANIONS				PARAMETERS							
			Ca	K	Mg	Na	Cl	F	NO_3	SO_4	Alkalinity	Conductivity	Temperature	Hardness	Lang. Index	pH	TDS	Turbidity
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	(mg/l $CaCO_3$)	(µmhos/cm)	°C	(mg/l $CaCO_3$)			mg/l	NTU
1	ATIKOKAN WTP	ATIKOKAN RIVER	8 8	0 6	1 5	1 6	1 7	0 03	0 05	3 2	26	65	9 7	28	-1 40	7 57	104	1 87
2	BEARDMORE WTP	BLACKWATER RIVER	23 3	0 7	3 9	2 2	3 6	0 04	0 09	3 0	70	150	7 4	74	-0 28	7 91	97	1 48
3	CHAPLEAU WTP	CHAPLEAU RIVER	13 0	0 8	2 7	1 8	2 2	0 03	0 09	4 8	38	92	10 7	44	-0 95	7 75	60	1 77
4	EAR FALLS WTP	ENGLISH RIVER	11 4	0 7	2 6	1 2	0 6	0 04	0 06	2 5	38	81	7 3	39	-0 94	7 79	53	5 80
5	EMO WTP	RAINY RIVER	8 3	0 9	2 6	3 7	3 1	0 05	0 07	5 4	28	80	9 2	32	-1 39	7 60	52	6 51
6	FORT FRANCES WTP	RAINY RIVER	5 8	0 7	1 9	1 4	1 0	0 05	0 06	3 6	20	53	9 1	22	-1 77	7 49	35	1 62
7	HAWKESBURY WTP	OTTAWA RIVER	10 8	1 1	2 7	4 1	5 0	0 05	0 26	8 8	30	99	9 5	38	-1 22	7 66	64	9 35
8	NIPIGON WTP	NIPIGON RIVER	24 5	0 6	4 2	1 3	1 1	0 03	0 06	2 7	78	154	7 3	78	0 08	8 17	100	3 04
9	OTTAWA (BRITANNIA) WSS	OTTAWA RIVER	8 9	0 9	2 2	2 6	2 7	0 08	0 19	8 7	24	80	14 4	31	-1 43	7 62	49	3 10
10	OTTAWA (LEMIEUX ISLAND) WSS	OTTAWA RIVER	8 5	0 8	2 1	2 8	2 9	0 05	0 22	8 8	22	77	10 7	30	-1 51	7 56	50	2 93
11	PEMBROKE WTP	OTTAWA RIVER	5 7	0 7	1 7	2 3	1 9	0 04	0 22	8 4	15	60	10 2	21	-2 04	7 38	39	2 66
12	RAINY RIVER WTP	RAINY RIVER	10 1	0 9	3 3	3 4	2 7	0 05	0 08	26 2	35	92	9 9	39	-1 15	7 66	61	1 90
13	RENFREW WTP	BONNECHERE RIVER	22 9	1 4	6 0	4 7	6 2	0 07	0 07	3 0	72	184	12 0	82	-0 17	8 05	120	2 68
14	ROCKLAND WTP	OTTAWA RIVER	10 1	0 9	2 5	4 1	5 4	0 06	0 23	12 5	28	96	9 3	36	-1 36	7 61	62	4 79
15	SUDBURY (WANAPITEI) WSS	WANAPITEI RIVER	8 5	0 5	2 0	1 3	1 1	0 06	0 17	23 7	17	70	11 5	29	-1 69	7 50	213	3 20
		NUMBER OF PLANTS	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		AVERAGE	12 0	0 8	2 8	2 6	2 7	0 05	0 13	8 3	36	96	9 9	42	-1 1	7 7	77	3 51
		MINIMUM	5 7	0 5	1 5	1 2	0 6	0 03	0 05	2 5	15	53	7 3	21	-2 0	7 4	35	1 48
		MAXIMUM	24 5	1 4	6 0	4 7	6 2	0 08	0 26	26 2	78	184	14 4	82	0 1	8 2	213	9 35

Table 10. Average Ground Water chemical/physical parameters in the DWSP water treatment facilities in Ontario

PLANT (SOUTHERN ONTARIO)	Average Cations				Average Anions				PARAMETERS							
	Ca	K	Mg	Na	Cl	F	NO3	SO4	Alkalinity	Conductivity	Temperature	Hardness	Lang. Index	pH	TDS	Turbidity
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	(mg/l CaCO3)	µmhos/Cm	°C	(mg/l CaCO3)			(mg/l)	NTU
AURORA WELL SUPPLY	48.1	1.3	17.7	10.8	1.5	0.12	0.02	2.0	221	392	9.3	191	0.88	8.31	255	5.93
BARRIE WELL SUPPLY	65.1	1.7	17.0	18.9	39.6	0.08	0.50	18.7	213	540	8.2	234	0.93	8.27	343	2.33
CAMBRIDGE WELL SUPPLY	96.1	1.9	33.2	49.0	104.6	0.24	0.80	80.4	267	932	10.7	376	0.99	8.08	614	5.40
DELHI (SPRING SUPPLY)	85.0	1.3	17.5	25.9	54.1	0.08	5.08	44.2	213	665	8.5	291	1.04	8.26	432	0.41
DORCHESTER WELL SUPPLY	71.0	1.0	14.6	15.0	30.4	0.09	1.48	44.4	186	508	7.5	238	0.80	6.80	403	0.96
ELMIRA WELL SUPPLY	109.8	3.5	33.4	11.5	19.8	0.25	4.73	155.6	245	809	9.0	412	1.03	8.10	569	1.20
GUELPH WELL SUPPLY	103.2	1.9	33.1	42.4	80.7	0.22	1.85	92.6	279	898	9.6	393	1.05	8.11	581	0.66
KITCHENER WELL SUPPLY	115.0	1.8	34.1	39.0	72.3	0.27	0.95	150.0	269	940	10.2	429	1.02	8.09	599	8.13
MANITOUWADGE WELL SUPPLY	105.3	2.2	20.0	21.1	52.3	0.09	0.92	48.8	275	744	4.8	345	1.04	8.09	472	0.28
MILTON WELL SUPPLY	68.5	1.6	30.2	14.7	30.7	0.09	1.32	42.0	242	604	10.4	295	0.85	8.13	393	1.27
NEWMARKET WELL SUPPLY	43.0	1.2	18.9	16.9	8.5	0.17	0.17	6.3	212	409	7.8	174	0.73	8.26	267	2.62
NORWICH WELL SUPPLY	58.3	1.5	27.9	22.0	18.4	0.87	0.01	46.1	244	558	5.2	262	0.94	8.28	345	7.48
ORANGEVILLE WELL SUPPLY	76.4	1.3	24.8	10.7	22.1	0.17	1.08	47.0	240	578	8.0	294	0.98	8.21	386	2.10
OTTERVILLE WELL SUPPLY	77.2	1.3	13.6	15.1	23.9	0.08	2.63	43.9	200	531	4.6	249	0.86	8.14	342	0.39
OWEN SOUND (SPRING SUPPLY)	81.9	1.7	27.6	9.3	17.1	0.05	3.28	18.1	295	610	6.8	312	1.09	8.20	397	0.35
PENETANGUISHENE WELL SUPPLY	63.2	1.8	13.7	9.8	-	0.07	1.77	12.5	183	440	8.0	214	0.99	8.38	286	0.06
PORT DOVER (SPRING SUPPLY)	74.8	0.9	18.3	4.0	7.8	0.09	2.29	59.1	198	494	10.2	262	1.03	8.32	321	0.88
SIMCOE WELL SUPPLY	85.7	1.1	15.3	27.5	48.2	0.09	2.97	54.5	208	640	8.6	277	1.06	8.29	396	2.71
STOUFFVILLE WELL SUPPLY	90.4	1.3	17.0	12.8	33.0	0.05	1.71	44.7	230	604	7.5	295	0.99	8.15	375	1.86
STRATFORD WELL SUPPLY	122.8	1.8	32.6	20.5	4.8	1.61	0.03	258.3	225	847	8.3	441	1.12	8.24	628	6.00
THAMESVILLE WELL SUPPLY	93.4	1.5	14.3	12.1	14.1	0.28	0.01	33.0	270	583	10.7	292	1.02	8.09	379	6.44
TILLSONBURG WELL SUPPLY	68.5	1.1	15.9	20.6	24.0	0.34	1.92	46.3	202	527	8.4	236	0.90	8.27	351	2.38
TRENTON (VICTORIA ST PUMPIN	72.1	1.7	9.8	24.5	42.4	0.11	1.02	22.2	195	530	10.5	220	0.89	8.22	341	0.24
WATERLOO WELL SUPPLY	141.3	2.5	42.0	51.2	102.9	0.27	1.70	223.3	272	1149	9.7	533	1.08	8.08	792	0.93
WOODSTOCK WELL SUPPLY	89.9	1.9	33.9	14.8	44.1	0.44	4.91	46.7	270	841	7.8	364	0.81	8.22	512	2.02
NUMBER OF PLANTS	25	25	25	25	24	25	25	25	25	25	25	25	25	25	25	25
AVERAGE	84.2	1.6	23.1	20.8	37.4	0.2	1.7	65.6	234.1	654.8	8.4	305.2	1.0	8.1	431.2	2.5
MINIMUM	43.0	0.9	9.8	4.0	1.5	0.0	0.0	2.0	183.1	391.8	4.6	174.2	0.7	6.8	255.0	0.1
MAXIMUM	141.3	3.5	42.0	51.2	104.6	1.6	5.1	258.3	294.5	1148.8	10.7	533.3	1.1	8.4	792.0	8.1

PLANT (CANADIAN SHIELD)	Average Cations				Average Anions				PARAMETERS							
	Ca	K	Mg	Na	Cl	F	NO3	SO4	Alkalinity	Conductivity	Temperature	Hardness	Lang. Index	pH	TDS	Turbidity
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	(mg/l CaCO3)	µmhos/Cm	°C	(mg/l CaCO3)			(mg/l)	NTU
BLEZARD VALLEY WELL SUPPLY	36.4	1.1	6.4	23.4	44.6	0.06	0.99	22.5	86	354	No Data	117	0.02	8.05	228	0.22
BRACEBRIDGE (LEADER SPRING)	11.5	1.7	2.8	13.4	28.4	0.02	1.97	7.7	18	167	7.7	40	-1.86	7.20	111	0.25
CAPREOL WELL SUPPLY	21.2	1.5	5.1	11.4	20.3	0.06	0.27	13.4	59	210	No Data	74	-1.32	7.48	195	1.20
DOWLING WELL SUPPLY	24.3	2.0	5.7	16.1	34.2	0.12	0.61	20.2	55	265	No Data	87	-0.62	7.75	169	0.10
GARSON WELL SUPPLY	46.0	0.9	12.3	15.4	31.8	0.04	1.63	52.9	96	405	No Data	165	0.32	8.16	268	0.14
MARATHON WELL SUPPLY	55.7	1.8	10.8	8.9	25.1	0.09	0.98	11.7	160	410	5.1	184	0.77	8.28	272	0.60
SAULT STE MARIE WELL SUPPLY	33.0	1.9	6.1	15.7	39.1	0.11	0.35	11.4	77	303	7.7	107	0.10	8.16	205	0.22
NUMBER OF PLANTS	7	7	7	7	7	7	7	7	7	7	3	7	7	7	7	7
AVERAGE	32.6	1.5	7.0	14.9	31.9	0.07	0.97	20.0	79	302	6.8	111	-0.37	7.87	207	0.39
MINIMUM	11.5	0.9	2.8	8.9	20.3	0.02	0.27	7.7	18	167	5.1	40	-1.86	7.20	111	0.10
MAXIMUM	55.7	2.0	12.3	23.4	44.6	0.12	1.97	52.9	160	410	7.7	184	0.77	8.28	272	1.20

Table 11. A summary of the DWSP raw water types for lake, river, and ground water used by water treatment plants in Ontario

Raw water source (total No of Samples)	Dominant Cations	Dominant Anions	Water type	No of Samples	Percent of Samples
Lakes Southern Ontario (46)	Ca	HCO_3	$CaHCO_3$	46	100
Lakes Canadian Shield (15)	Ca,	HCO_3	$CaHCO_3$	10	66.6
	X	X	X	3	20
	Na+K	Cl	Na+K Cl	1	13
Rivers Southern Ontario (27)	Ca	HCO_3	$CaHCO_3$	27	100
Rivers Canadian Shield (15)	Ca	HCO_3	$CaHCO_3$	14	93.3
	Ca	SO_4+NO_3	$CaSO_4NO_3$	1	6.6
Ground water Southern Ontario (25)	Mg	SO_4+NO_3	$CaSO_4NO_3$	18	72
	Ca	HCO_3	$CaHCO_3$	7	28
Ground water Canadian Shield (7)	Ca	HCO_3	$CaHCO_3$	3	42.8
	Ca	X	CaX	3	42.8
	X	Cl	XCl	1	14.3

X = No dominant ions

Table 12. Percentages of Ground water Types in various Bedrock Geology of Southern Ontario*

Lithology	Bedroc Unit	No of Samples	Cation Dominant (%)			Anion Dominant (%)			Cation-Anion Pairs Dominant (%)							No Dominant (%)
			Ca	Mg	Na+K	HCO_3	O_4+NO	Cl	Ca HCO	Mg HCO_3	Na+K HCO_3	Ca O_4+NO	Na+K Cl	Mg O_4+NO	Na+K SO_4+NO_3	
Shale	Rockliffe	1				100										
	Billing-Carls.	10			10	20			10		20		30			10
	Georgian Bay	12	8	8.3		33.3			8.3		16.7		25			
	Queenston	10	10		10				30			20	10			20
	Hamilton	3							33		33.3		33.3			
	Kettle Point	6							17		49.9		33.3			
Carbonate & Evaporite	Salina Fm.	55	2			5.5	7.3		24			60				1.8
	Ditroit River Fm	40	5			22.5	5		43	10	2.5	2.5		10		
Carbonate	Ottawa Grp.	32			3.1	31.3			41		15.6		9.4			
	Simcoe Grp.	34	3		2.9	20.6		2.9	35		14.7		2.9		11.8	5.9
	Amabel Fm	69				10.1			78			8.7				2.9
	Guelph Fm.	43	2		4.7	25.6	7		37			16.3				7
	Bass Island Fm.	12	8			8.3			33		8.3	41.7				
	Bois Blanc Fm.	17	6			29.4	11.8		24	5.9		23.5				
	Dundee Fm.	27	4	3.7	3.7	37	7.4		11	3.7	14.8	3.7	3.7			7.4
Sandstone	Nepean Fm.	28				46.4		3.6	36	3.6	3.6	3.6				3.6
Igneous	Precambrian	3				33.3			67							

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* Abstracted from Appendix IV in Hydrogeology of southern Ontario (Singer et al. 1996).

Table 13-a. DWSP average metal concentrations in lake water in Ontario

PLANT	RAW SOURCE	Al	As	B	Cd	Cu	Fe	Hg	Mn	Mo	Pb	Sr	U	Zn
SOUTHERN ONTARIO		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
AJAX WTP	LAKE ONTARIO	67	0.73	27	0.05	2.60	46	0.02	3	1.17	0.20	181	0.37	3.12
ALEXANDRIA WTP	MILL LAKE/GLENGARRY	15	0.47	11	0.05	0.67	97	0.02	23	0.10	1.41	96	0.05	2.35
BEAVERTON WTP	LAKE SIMCOE	20	0.48	25	0.14	1.42	29	0.02	4	0.42	0.39	153	0.36	6.24
BELLE RIVER WTP	LAKE ST CLAIR	240	0.65	21	0.06	1.74	311	0.02	13	0.63	0.70	168	0.66	5.25
BELLEVILLE WTP	BAY OF QUINTE	126	0.55	18	0.06	1.13	185	0.02	37	0.24	1.09	134	0.23	3.75
BURLINGTON WSS	LAKE ONTARIO	20	0.72	27	0.06	2.06	30	0.02	3	1.19	0.24	185	0.32	3.78
CHATHAM WTP	LAKE ERIE	143	0.96	23	0.05	2.79	368	0.02	65	1.00	0.48	148	0.38	4.15
COBOURG WTP	LAKE ONTARIO	19	0.89	29	0.06	1.32	26	0.02	2	1.10	0.22	180	0.33	2.48
COLLINGWOOD WTP	GEORGIAN BAY	11	0.42	17	0.05	0.65	11	0.02	2	0.38	0.14	91	0.17	1.54
DESERONTO WTP	BAY OF QUINTE	52	1.21	19	0.06	1.21	90	0.02	29	0.33	4.11	186	0.22	6.61
DUNNVILLE (INDUSTRIAL)	LAKE ERIE	87	0.77	27	0.05	14.46	104	0.02	6	1.04	0.33	191	0.39	4.73
DUNNVILLE WTP	LAKE ERIE	63	0.75	24	0.05	2.67	76	0.02	5	1.09	0.28	185	0.38	4.31
FORT ERIE (ROSEHILL) WTP	LAKE ERIE	56	0.71	22	0.05	1.27	81	0.02	7	1.03	0.24	169	0.36	3.00
GODERICH WTP	LAKE HURON	114	0.50	19	0.06	1.18	140	0.02	8	0.39	0.43	214	0.34	2.48
GRIMSBY WTP	LAKE ONTARIO	10	0.88	30	0.08	1.61	12	0.02	2	1.30	0.32	185	0.34	4.06
GRIMSBY WTP	LAKE ONTARIO	90	0.70	28	0.05	5.31	120	0.02	11	1.10	0.50	186	0.33	3.76
HALDIMAND-NORFOLK WSS	LAKE ERIE	51	0.85	25	0.10	2.77	59	0.02	4	1.34	0.41	189	0.36	4.15
HAMILTON WSS	LAKE ONTARIO	28	0.78	27	0.05	1.83	51	0.02	6	1.19	0.25	182	0.33	3.62
HARROW-COLCHESTER SOUTH WSS	LAKE ERIE	211	0.65	19	0.06	85.25	359	0.02	16	0.48	1.52	120	0.32	8.57
KINGSTON WTP	LAKE ONTARIO	20	0.83	27	0.05	13.34	21	0.02	5	1.06	0.18	183	0.30	3.21
LONDON (LAKE HURON) WSS	LAKE HURON	41	0.55	16	0.05	7.27	51	0.02	3	0.45	0.38	111	0.22	6.33
METRO TORONTO (F J HORGAN)	LAKE ONTARIO	17	0.85	26	0.05	26.98	36	0.02	3	1.15	0.26	181	0.33	3.67
METRO TORONTO (ISLAND) WTP	LAKE ONTARIO	13	0.81	29	0.05	1.31	22	0.02	3	1.12	0.18	176	0.31	2.13
METRO TORONTO (R C HARRIS	LAKE ONTARIO	19	0.86	27	0.06	12.62	30	0.02	3	1.12	0.30	178	0.31	2.93
METRO TORONTO (R L CLARK)	LAKE ONTARIO	23	0.89	30	0.06	1.26	32	0.02	3	1.10	0.16	179	0.29	2.38
MITCHELLS BAY WTP	LAKE ST CLAIR	204	0.64	24	0.05	3.44	134	0.02	6	0.80	0.44	131	0.61	6.93
NAPANEE WTP	LAKE ONTARIO	14	0.81	26	0.06	1.37	23	0.03	6	0.96	0.19	192	0.28	2.35
OAKVILLE WTP	LAKE ONTARIO	39	0.80	27	0.07	1.75	62	0.02	5	1.10	0.40	178	0.33	3.66
OSHAWA WSS	LAKE ONTARIO	23	0.94	27	0.05	2.32	32	0.02	3	1.20	0.26	182	0.33	3.36
OWEN SOUND (R H NEATH) WT	GEORGIAN BAY	19	0.39	15	0.06	4.06	42	0.03	3	0.37	0.19	89	0.18	1.82
PICTON WTP	BAY OF QUINTE	293	1.17	20	0.05	1.14	61	0.02	20	0.54	0.49	185	0.24	3.25
PORT COLBORNE WTP	LAKE ERIE	64	0.80	25	0.06	6.98	90	0.02	5	1.13	0.32	172	0.36	2.88
PORT DOVER WSS	LAKE ERIE	174	0.78	26	0.07	1.81	240	0.02	37	1.00	0.43	193	0.38	3.70
PORT ELGIN WTP	LAKE HURON	39	0.57	17	0.05	2.18	53	0.02	4	0.41	0.21	125	0.22	4.93
PORT HOPE WTP	LAKE ONTARIO	38	0.83	26	0.05	1.27	52	0.02	4	1.10	0.17	180	0.33	2.61
PORT ROWAN WTP	LAKE ERIE	286	0.61	22	0.05	0.95	245	0.02	30	0.38	0.44	212	0.53	2.61
PORT STANLEY WTP	LAKE ERIE	375	0.82	24	0.05	12.84	643	0.02	29	0.82	0.82	158	0.46	9.12
SOUTH PEEL (LAKEVIEW) WSS	LAKE ONTARIO	57	0.73	29	0.06	14.27	96	0.02	7	1.09	0.72	182	0.35	6.12
SOUTH PEEL (LORNE PARK) WSS	LAKE ONTARIO	28	0.82	30	0.06	16.68	46	0.02	4	1.14	0.38	185	0.32	3.56
SOUTHAMPTON WTP	LAKE HURON	40	0.50	21	0.05	1.77	53	0.02	4	0.43	0.32	186	0.27	4.82
ST THOMAS (ELGIN) WSS	LAKE ERIE	322	0.96	24	0.05	2.36	681	0.02	55	0.76	2.49	160	0.39	4.31
STONEY POINT (TILBURY NORTH	LAKE ST CLAIR	117	0.60	22	0.05	4.85	133	0.02	5	0.86	0.70	165	0.56	6.72
TECUMSEH WTP	LAKE ST CLAIR	242	0.71	31	0.06	12.36	348	0.02	25	1.05	0.84	258	0.81	5.51
TILBURY WTP	LAKE ST CLAIR	36	0.76	13	0.05	15.44	183	0.02	100	0.19	1.36	187	0.36	3.74
UNION (ESSEX COUNTY) WSS	LAKE ERIE	143	0.59	19	0.06	1.62	236	0.02	11	0.56	0.75	124	0.31	3.83
WHITBY WTP	LAKE ONTARIO	11	0.87	29	0.07	1.18	64	0.02	2	1.23	0.98	183	0.33	2.46
	NUMBER OF PLANTS	46	46	46	46	46	46	46	46	46	46	46	46	46
	AVERAGE	90	0.74	24	0.06	6.64	128	0.02	14	0.84	0.60	169	0.35	4.06
	MINIMUM	10	0.39	11	0.05	0.65	11	0.02	2	0.10	0.14	89	0.05	1.54
	MAXIMUM	375	1.21	31	0.14	85.25	681	0.03	65	1.34	4.11	258	0.81	9.12
PLANT														
CANADIAN SHEILDS														
BRACEBRIDGE WTP	LAKE MUSKOKA	29	0.16	6	0.05	0.70	47	0.02	6	0.08	0.09	32	0.05	5.94
COCHENOUR WTP	RED LAKE/BRUCE CHAN	21	7.24	5	0.06	2.21	90	0.02	5	0.15	0.35	24	0.06	10.1
DRYDEN WTP	LAKE WABIGOON	343	0.48	6	0.08	2.55	395	0.02	10	0.13	0.43	29	0.08	3.73
GRAVENHURST WTP	LAKE MUSKOKA	100	0.15	7	0.05	8.42	46	0.02	6	0.06	0.32	32	0.05	7.03
HUNTSVILLE WTP	FAIRY LAKE	385	0.18	7	0.05	0.90	219	0.02	28	0.07	0.18	30	0.05	8.34
KENORA WTP	LAKE OF THE WOODS	35	0.84	10	0.05	1.49	49	0.02	9	0.21	0.23	31	0.07	8.24
MADSEN WTP	RUSSET LAKE	5	6.81	11	0.06	1.58	50	0.02	23	0.13	0.10	33	0.05	3.72
NORTH BAY WTP	TROUT LAKE	17	0.17	9	0.05	2.66	49	0.02	7	0.15	0.25	45	0.05	9.42
RED LAKE WTP	RED LAKE	14	5.10	6	0.05	1.45	49	0.02	4	0.17	0.13	23	0.06	4.19
RED ROCK WTP	LAKE SUPERIOR	52	0.76	6	0.06	1.36	144	0.02	10	0.10	0.11	24	0.10	2.75
SAULT STE MARIE WTP	LAKE SUPERIOR	15	0.41	8	0.05	4.77	23	0.02	2	0.13	0.13	24	0.11	1.72
SUDBURY (DAVID ST) WTP	RAMSEY LAKE	8	0.85	13	0.21	21.00	93	0.02	47	0.20	0.71	54	0.06	10.3
TERRACE BAY WTP	LAKE SUPERIOR	7	0.51	7	0.05	1.44	9	0.02	1	0.12	0.08	23	0.06	1.62
THUNDER BAY (BARE POINT) WT	LAKE SUPERIOR	16	0.45	7	0.05	1.25	23	0.02	2	0.12	0.45	23	0.05	1.85
THUNDER BAY (LOCH LOMOND) W	LOCH LOMOND	8	0.25	6	0.05	2.36	27	0.02	3	0.10	0.22	14	0.05	2.91
	NUMBER OF PLANTS	15	15	15	15	15	15	15	15	15	15	15	15	15
	AVERAGE	70	1.63	8	0.07	3.61	88	0.02	11	0.13	0.25	29	0.06	5.46
	MINIMUM	5	0	5	0.05	0.70	9	0.02	1	0.06	0.08	14	0.05	1.62
	MAXIMUM	385	7	13	0.21	21.00	395	0.02	47	0.21	0.71	54	0.11	10.33

Table 13-b. DWSP average metal concentrations in river waters in Ontario

PLANT	SOURCE	Al	As	B	Cd	Cu	Fe	Hg	Mn	Mo	Pb	Sr	U	Zn
SOUTHERN ONTARIO		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
ALVINSTON WTP	SYDENHAM RIVER	360	1.03	39	0.06	2.29	601	0.02	77	0.47	1.29	202	1.44	6.79
AMHERSTBURG WSS	DETROIT RIVER	210	0.61	20	0.05	4.95	258	0.02	10	0.48	0.86	124	0.34	4.74
BRANTFORD WTP	GRAND RIVER/HOMEDALE	163	0.60	47	0.06	3.26	225	0.02	28	2.07	1.15	553	0.76	11.61
BROCKVILLE WTP	ST LAWRENCE RIVER	13	0.89	26	0.05	3.48	27	0.02	3	1.10	0.31	175	0.31	2.96
CASSELMAN WTP	SOUTH NATION RIVER	336	0.66	38	0.07	3.78	440	0.03	55	2.70	0.60	581	1.48	6.62
CAYUGA WTP	GRAND RIVER	1052	0.50	51	0.07	16.64	443	0.02	57	1.34	3.17	693	0.75	16.10
CHARLOTTENBURGH WTP	ST LAWRENCE RIVER	22	0.79	28	0.05	1.09	31	0.03	3	1.06	0.17	180	0.31	4.65
CORNWALL WTP	ST LAWRENCE RIVER	23	0.76	26	0.05	1.46	33	0.02	4	1.09	0.39	181	0.31	2.22
DELHI WTP	NORTH CREEK/LEHMAN R	25	0.83	24	0.06	1.65	253	0.02	101	0.80	0.19	202	1.13	4.61
DRESDEN WTP	SYDENHAM RIVER	468	1.09	42	0.06	9.06	483	0.02	59	1.00	1.38	229	1.95	11.55
KITCHENER (MANNHEIM) WTP	GRAND RIVER	185	0.67	27	0.06	4.72	231	0.02	36	0.56	0.92	302	0.80	17.16
LINDSAY WTP	SCOUGOG RIVER	308	0.50	16	0.12	3.39	135	0.02	40	0.30	0.88	182	0.50	7.20
NIAGARA FALLS WTP	NIAGARA RIVER/WELLAN	32	0.75	24	0.05	1.18	46	0.02	3	1.12	0.16	151	0.35	1.84
ODESSA WTP	MILLHAVEN CREEK	406	0.33	27	0.05	0.59	61	0.02	50	0.11	1.12	1111	0.07	2.12
OHSWEKEN WTP	GRAND RIVER	655	0.63	44	0.07	4.44	374	0.02	48	1.17	1.10	520	0.74	10.65
PERTH WTP	TAY RIVER	21	0.26	14	0.05	0.57	97	0.02	25	0.18	0.22	103	0.13	1.84
PETERBOROUGH WSS	OTONABEE RIVER	13	0.28	11	0.06	2.06	42	0.02	18	0.23	0.19	108	0.18	2.16
PLANTAGENET WTP	SOUTH NATION RIVER	1409	0.64	40	0.09	11.09	1830	0.02	165	0.53	1.30	345	1.14	31.95
PRESCOTT WTP	ST LAWRENCE RIVER	22	0.74	26	0.08	3.73	47	0.02	6	1.05	0.39	175	0.31	3.15
SARNIA (LAMBTON COUNTY) WTP	ST CLAIR RIVER/LAKE	30	0.53	16	0.05	48.27	49	0.02	3	0.48	0.36	102	0.22	5.41
SMITH FALLS WTP	RIDEAU RIVER	29	0.32	16	0.05	1.11	64	0.02	25	0.19	0.32	127	0.14	6.92
ST CATHARINES (DE CEW) WSS	WELLAND CANAL	70	0.82	27	0.10	11.03	102	0.02	6	1.07	0.50	175	0.36	15.15
TRENTON WTP	TRENT RIVER	51	0.36	14	0.05	0.90	111	0.02	27	0.24	0.73	132	0.22	3.99
WALLACEBURG WTP	ST CLAIR RIVER/CHENA	133	0.58	18	0.06	2.90	163	0.02	7	0.47	0.89	105	0.29	4.37
WALPOLE ISLAND WTP	ST CLAIR RIVER	55	0.50	16	0.05	1.41	96	0.02	4	0.47	0.25	101	0.22	2.51
WELLAND WSS	WELLAND CANAL	49	0.82	26	0.05	1.18	58	0.02	4	1.16	0.14	185	0.35	2.42
WINDSOR WSS	DETROIT RIVER	196	0.65	19	0.06	8.88	219	0.02	10	0.44	0.75	117	0.33	3.31
	NUMBER OF PLANTS	27	27	27	27	27	27	27	27	27	27	27	27	27
	AVERAGE	235	0.63	27	0.06	5.74	241	0.02	32	0.81	0.73	265	0.56	7.18
	MINIMUM	13	0.26	11	0.05	0.57	27	0.02	3	0.11	0.16	101	0.07	1.84
	MAXIMUM	1409	1.09	51	0.12	48.27	1830	0.03	165	2.70	3.17	1111	1.95	31.95

PLANT	SOURCE	Al	As	B	Cd	Cu	Fe	Hg	Mn	Mo	Pb	Sr	U	Zn
CANADIAN SHIELDS		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
ATIKOKAN WTP	ATIKOKAN RIVER	23	0.96	5	0.05	1.83	207	0.02	19	0.09	0.27	24	0.05	2.14
BEARDMORE WTP	BLACKWATER RIVER	180	2.57	9	0.05	1.33	142	0.02	13	0.08	0.09	27	0.07	3.98
CHAPLEAU WTP	CHAPLEAU RIVER	76	0.36	6	0.06	0.88	201	0.02	29	0.08	0.15	26	0.05	4.90
EAR FALLS WTP	ENGLISH RIVER	140	0.58	5	0.05	4.70	196	0.02	7	0.13	0.37	20	0.08	2.78
EMO WTP	RAINY RIVER	114	0.55	8	0.05	1.37	242	0.02	22	0.12	1.41	25	0.10	4.40
FORT FRANCES WTP	RAINY RIVER	45	0.37	7	0.05	2.11	83	0.02	5	0.07	0.16	21	0.07	2.84
HAWKESBURY WTP	OTTAWA RIVER	231	0.46	7	0.08	1.84	360	0.02	22	0.20	0.35	57	0.12	5.27
NIPIGON WTP	NIPIGON RIVER	48	0.85	5	0.06	1.87	73	0.02	4	0.10	0.15	23	0.10	1.55
OTTAWA (BRITANNIA) WSS	OTTAWA RIVER	132	0.81	6	0.05	49.20	182	0.02	13	0.20	0.48	41	0.07	5.17
OTTAWA (LEMIEUX ISLAND) WSS	OTTAWA RIVER	133	0.73	6	0.05	13.71	197	0.02	28	0.29	1.41	43	0.07	5.19
PEMBROKE WTP	OTTAWA RIVER	129	0.77	6	0.05	1.94	185	0.02	14	0.21	0.19	31	0.06	4.12
RAINY RIVER WTP	RAINY RIVER	122	0.65	8	0.05	1.17	265	0.02	26	0.13	0.22	27	0.11	3.16
RENFREW WTP	BONNECHERE RIVER	109	0.17	11	0.05	2.04	183	0.02	21	0.19	0.35	93	0.18	4.62
ROCKLAND WTP	OTTAWA RIVER	139	0.63	6	0.05	2.64	237	0.02	15	0.26	0.32	56	0.09	4.17
SUDBURY (WANAPITEI) WSS	WANAPITEI RIVER	57	0.84	6	0.07	6.11	160	0.02	15	0.11	0.25	24	0.05	4.37
	NUMBER OF PLANTS	15	15	15	15	15	15	15	15	15	15	15	15	15
	AVERAGE	112	0.75	7	0.06	6.18	194	0.02	17	0.15	0.41	36	0.08	3.91
	MINIMUM	23	0.17	5	0.05	0.88	73	0.02	4	0.07	0.09	20	0.05	1.55
	MAXIMUM	231	2.57	11	0.08	49.20	360	0.02	29	0.29	1.41	93	0.18	5.27

Table 13-c. DWSP average metal concentrations in ground water in Ontario

PLANT	Al	As	B	Cd	Cu	Fe	Hg	Mn	Mo	Pb	Sr	U	Zn
SOUTHERN ONTARIO	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
AURORA WELL SUPPLY	5	0.18	37	0.06	0.52	771	0.02	39	1.11	0.06	414	0.05	1.03
BARRIE WELL SUPPLY	4	0.25	23	0.10	1.63	383	0.02	44	0.59	0.28	261	0.39	5.36
CAMBRIDGE WELL SUPPLY	2	0.74	27	0.12	4.50	691	0.02	25	1.34	0.74	547	0.75	42.61
DELHI (SPRING SUPPLY)	5	0.32	26	0.05	1.18	7	0.02	3	0.13	0.08	146	0.42	3.10
DORCHESTER WELL SUPPLY	2	0.56	19	0.05	1.61	150	0.02	76	0.47	0.33	185	0.96	9.56
ELMIRA WELL SUPPLY	2	0.37	41	0.05	1.22	132	0.02	59	0.69	0.07	2078	0.86	8.02
GUELPH WELL SUPPLY	3	0.78	45	0.10	1.60	81	0.02	12	1.32	0.77	1756	1.16	75.22
KITCHENER WELL SUPPLY	4	1.74	50	0.06	6.30	488	0.02	142	0.99	0.42	2776	0.87	23.11
MANITOUWADGE WELL SUPPLY	3	0.48	23	0.05	2.39	38	0.02	103	0.40	0.09	127	1.74	3.79
MILTON WELL SUPPLY	6	0.24	40	0.05	5.30	10	0.02	3	1.05	0.37	181	0.65	4.04
NEWMARKET WELL SUPPLY	5	0.29	44	0.06	12.31	507	0.02	29	1.50	1.05	430	0.43	2.05
NORWICH WELL SUPPLY	4	6.90	98	0.06	0.54	720	0.02	24	3.20	0.06	5687	0.07	1.93
ORANGEVILLE WELL SUPPLY	4	1.04	24	0.05	0.59	168	0.02	19	0.72	0.24	373	0.44	6.98
OTTERVILLE WELL SUPPLY	2	0.32	21	0.05	0.82	28	0.02	10	0.25	0.05	300	0.35	5.63
OWEN SOUND (SPRING SUPPLY)	3	0.22	19	0.05	38.93	9	0.02	2	0.23	0.30	163	0.51	2.21
PENETANGUISHENE WELL SUPPLY	2	0.11	14	0.05	0.50	6	0.02	0	0.22	0.05	120	0.78	1.44
PORT DOVER (SPRING SUPPLY)	10	0.42	16	0.05	0.79	75	0.02	26	0.53	0.12	171	0.71	3.46
SIMCOE WELL SUPPLY	2	0.28	26	0.06	1.65	438	0.02	82	0.50	0.23	250	0.44	4.57
STOUFFVILLE WELL SUPPLY	3	0.31	16	0.05	0.63	139	0.02	20	0.63	0.13	200	2.49	2.50
STRATFORD WELL SUPPLY	3	1.37	84	0.06	0.75	528	0.02	8	2.77	0.12	14449	0.08	10.14
THAMESVILLE WELL SUPPLY	3	0.19	103	0.06	0.55	920	0.02	152	1.48	0.10	220	0.11	1.98
TILLSONBURG WELL SUPPLY	3	1.43	54	0.06	0.71	360	0.02	50	1.31	0.07	984	0.52	2.84
TRENTON (VICTORIA ST PUMPIN	3	0.32	14	0.05	1.31	6	0.02	7	0.26	0.18	188	0.40	2.08
WATERLOO WELL SUPPLY	2	0.88	60	0.06	1.20	81	0.02	39	0.60	0.15	2335	1.26	21.73
WOODSTOCK WELL SUPPLY	3	1.05	49	0.06	1.08	180	0.02	10	0.42	0.11	2465	0.61	4.21
NUMBER OF PLANTS	25	25	25	25	25	25	25	24	25	25	25	25	25
AVERAGE	4	0.83	39	0.06	3.54	277	0.02	41	0.91	0.25	1472	0.68	9.98
MINIMUM	2	0.11	14	0.05	0.50	6	0.02	2	0.13	0.05	120	0.05	1.03
MAXIMUM	10	6.90	103	0.12	38.93	920	0.02	152	3.20	1.05	14449	2.49	75.22

PLANT	Al	As	B	Cd	Cu	Fe	Hg	Mn	Mo	Pb	Sr	U	Zn
CANADIAN SHIELD	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
BLEZARD VALLEY WELL SUPPLY	4	0.75	11.163	0.05	1.03	35	0.02	23	0.40	0.10	67	0.4	1.9
BRACEBRIDGE (LEADER SPRING)	6	0.11	7	0.05	1.12	23	0.02	3	0.10	0.37	137	0.1	1.5
CAPREOL WELL SUPPLY	27	0.11	17	0.05	2.91	166	0.02	23	0.23	0.11	50	0.5	3.2
DOWLING WELL SUPPLY	3	0.26	15	0.11	0.74	7	0.02	3	1.41	0.12	60	0.3	1.5
GARSON WELL SUPPLY	4	2.68	9	0.15	1.36	15	0.02	17	0.37	0.14	59	1.3	1.9
MARATHON WELL SUPPLY	2	0.22	12	0.07	2.20	63	0.02	1	0.36	0.43	59	0.5	2.9
SAULT STE MARIE WELL SUPPLY	3	1.28	87	0.05	4.63	6	0.02	9	1.68	0.27	212	3.9	1.7
NUMBER OF PLANTS	7	7	7	7	7	7	7	7	7	7	7	7	7
AVERAGE	7	0.77	22	0.08	2.00	45	0.02	12	0.65	0.22	92	1.0	2.1
MINIMUM	2	0.11	7	0.05	0.74	6	0.02	1	0.10	0.10	50	0.1	1.5
MAXIMUM	27	2.68	87	0.15	4.63	166	0.02	23	1.68	0.43	212	3.9	3.2

Table 14. Summary of average concentrations of selected parameters in the DWSP source waters in Ontario

Patameter	S.Ontario	C.Shield	S.Ontario	C.Shield	S.Ontario	C.Shield
Hardness (CaCo3, mg/L)	129	38	172	42	305.2	111
TDS (mg/L)	169	41	253	77	431.2	207
Alkalinity(CaCo3, mg/L)	103	32	135	36	234	79
Conductivity (mmhos/cm)	299	105	391	96	654.8	302
Turbidity (NTU)	8.32	3.77	17.17	3.51	2.5	0.39
Langelier Index	0.62	-1.39	0.56	-1.1	1	-0.37
Temperature (D.Celcius)	10.0	7.7	11.1	9.9	8.4	6.8
pH	8.38	7.61	8.25	7.7	8.1	7.8
Iron (ppb)	128	88	241	194	277	45
Manganese (ppb)	14	11	32	17	41	12
Aluminum (ppb)	90	70	235	112	4	7

ILLUSTRATIONS

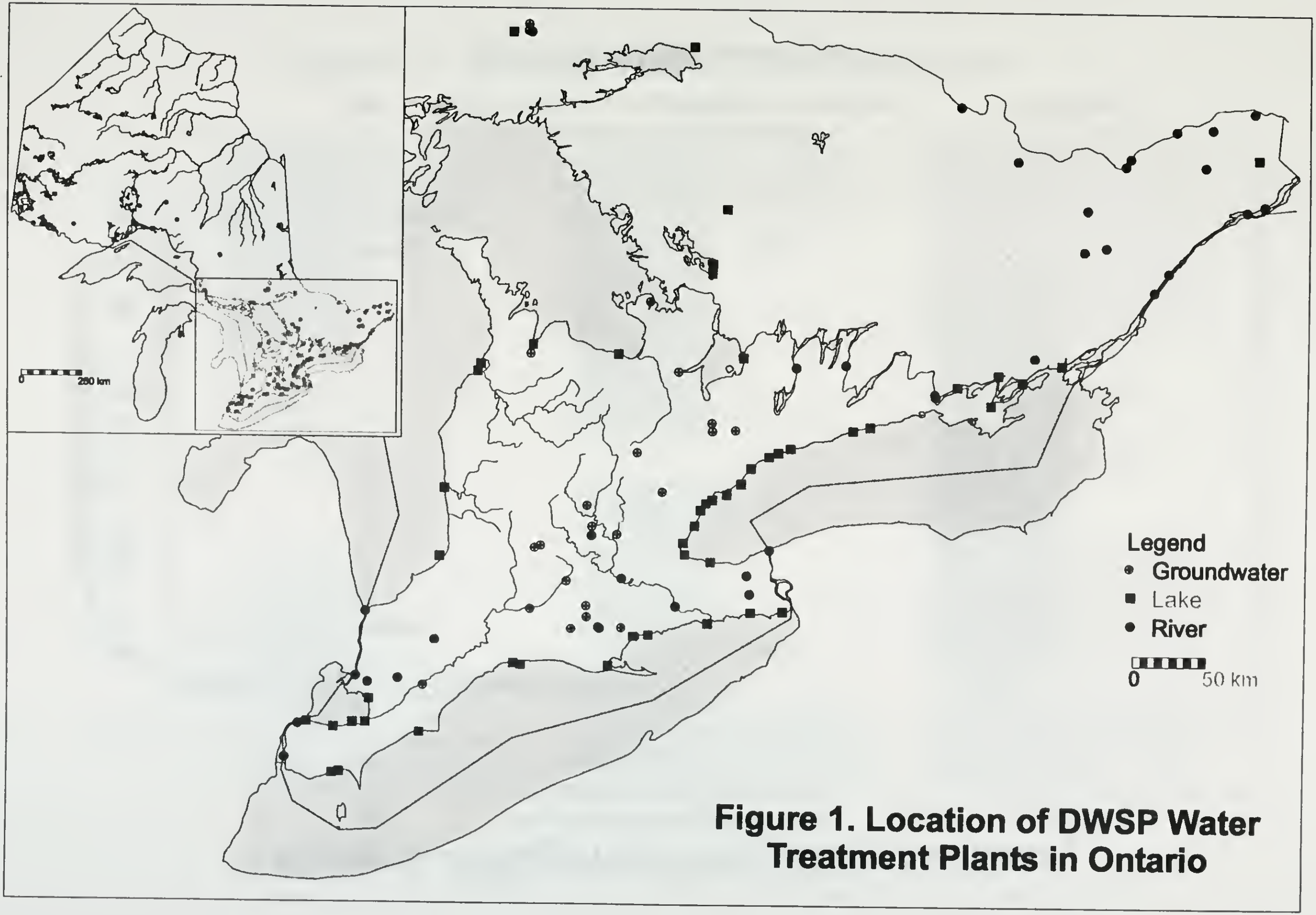


Figure 1. Location of DWSP Water Treatment Plants in Ontario

Figure 2. Average Hardness in Source Water
used in Water Treatment Facilities
in Ontario from the DWSP data

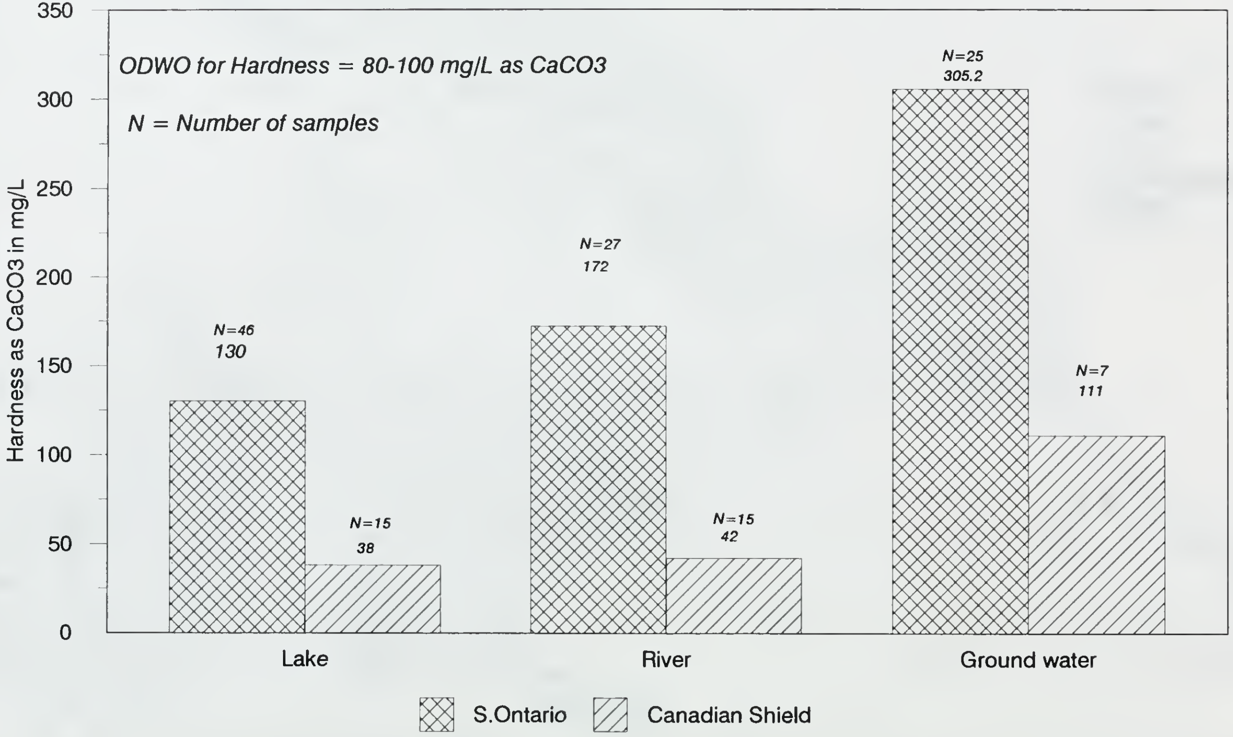


Figure 3. Average TDS Concentrations in
Source Water used in Water Treatment Facilities
in Ontario from the DWSP data

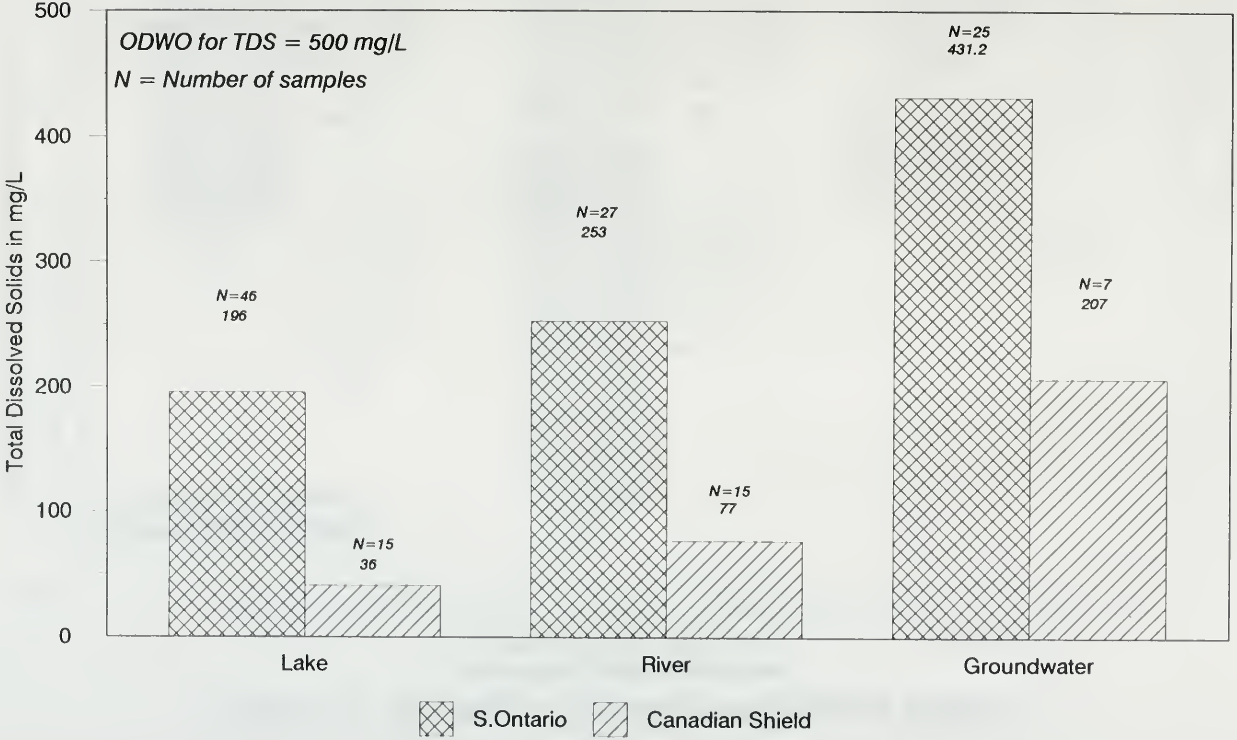


Figure 4. Average Turbidity in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data

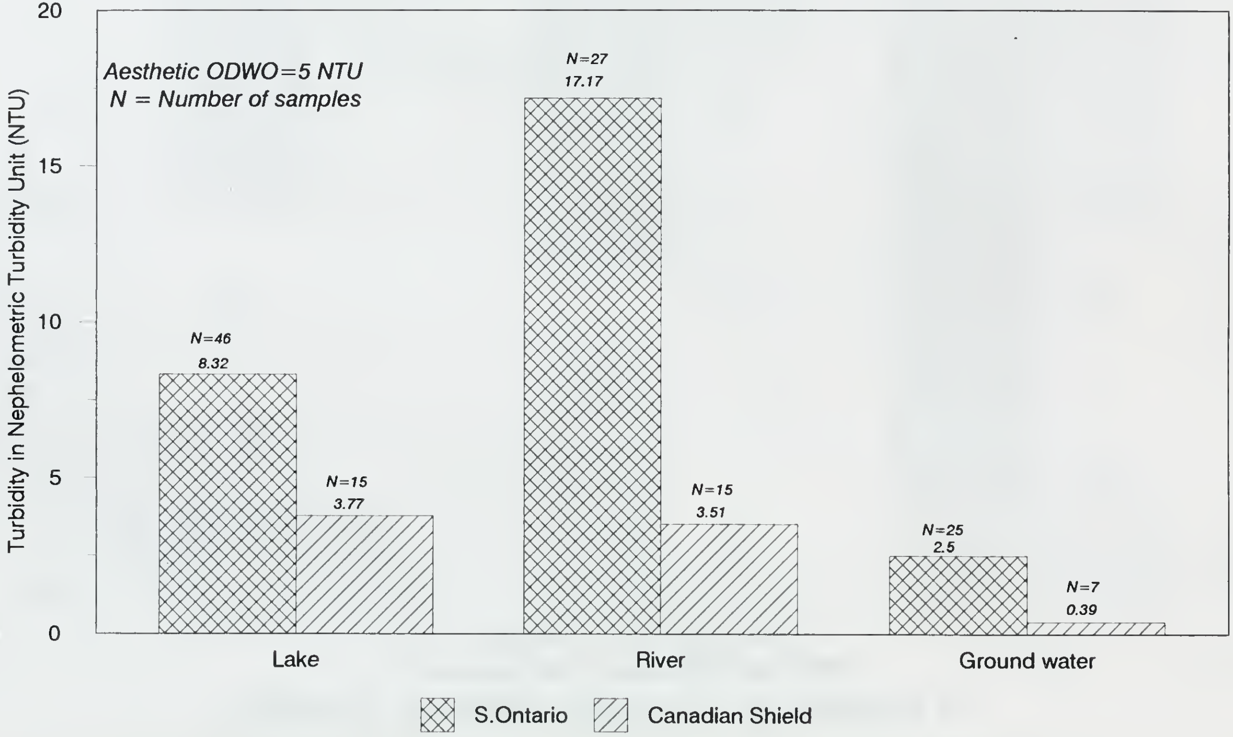


Figure 5. Langelier Index in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data

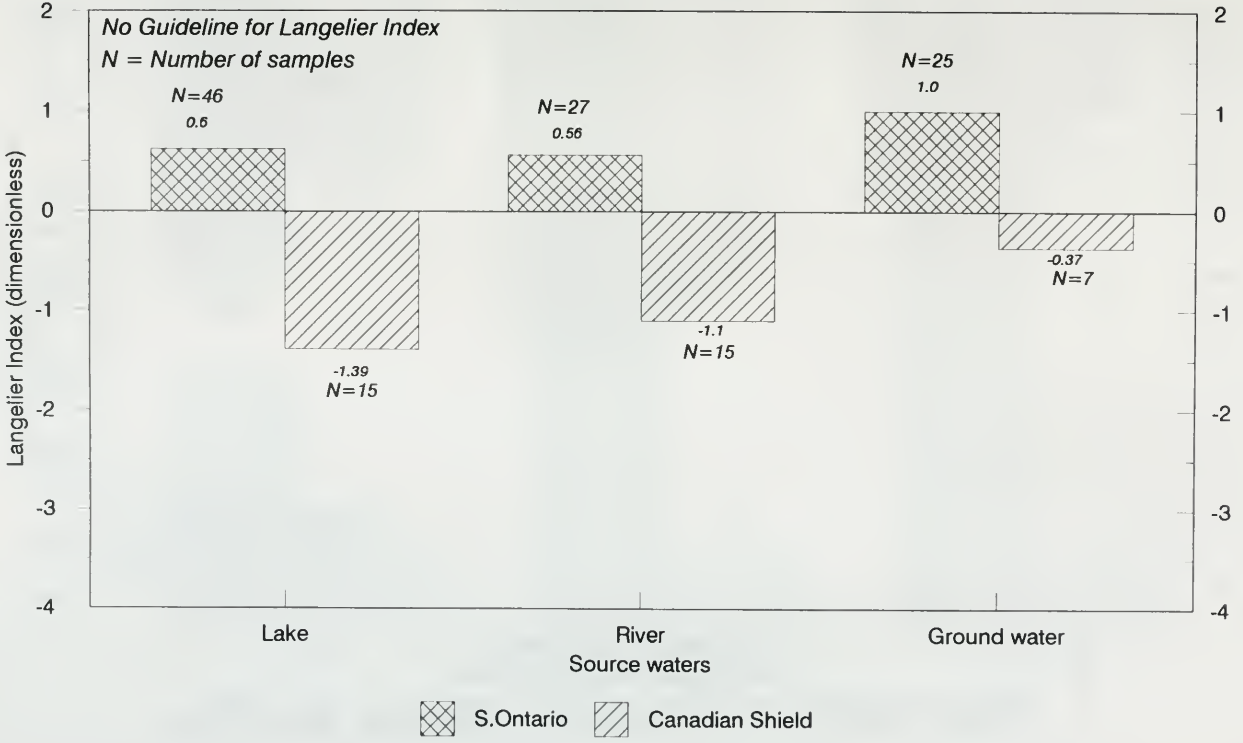


Figure 6. Average Temperature in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data

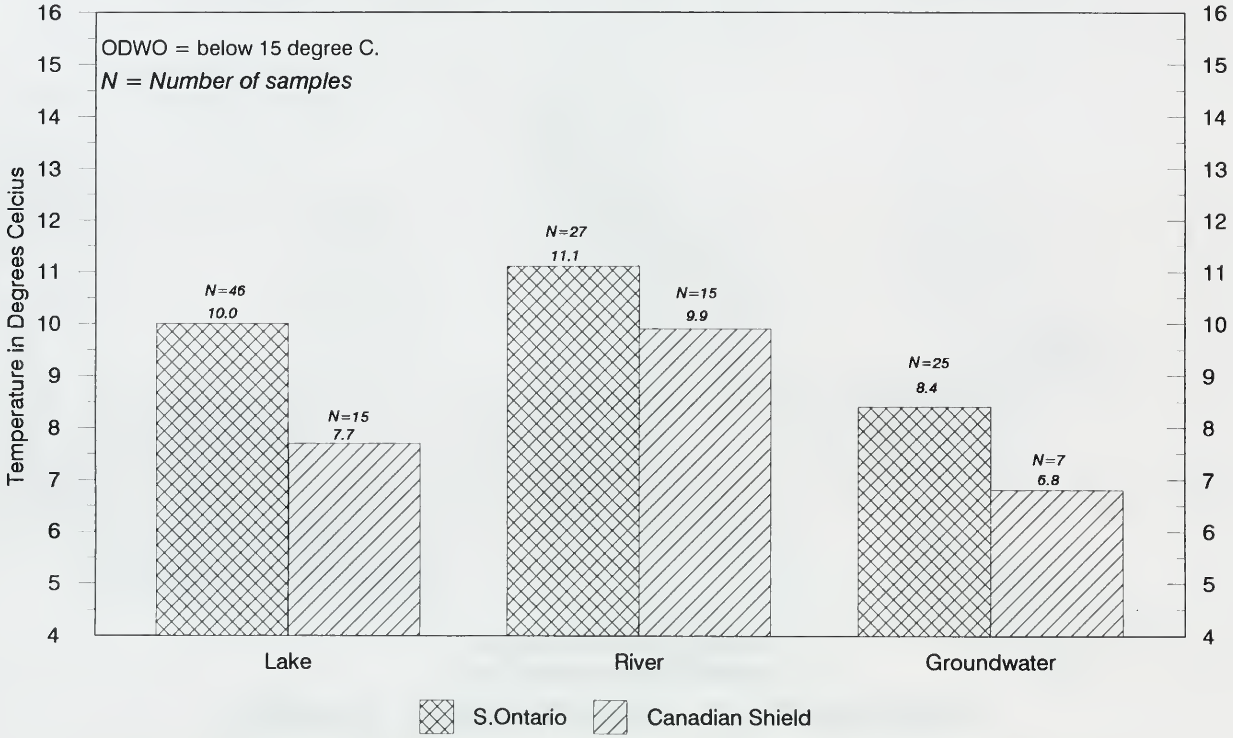
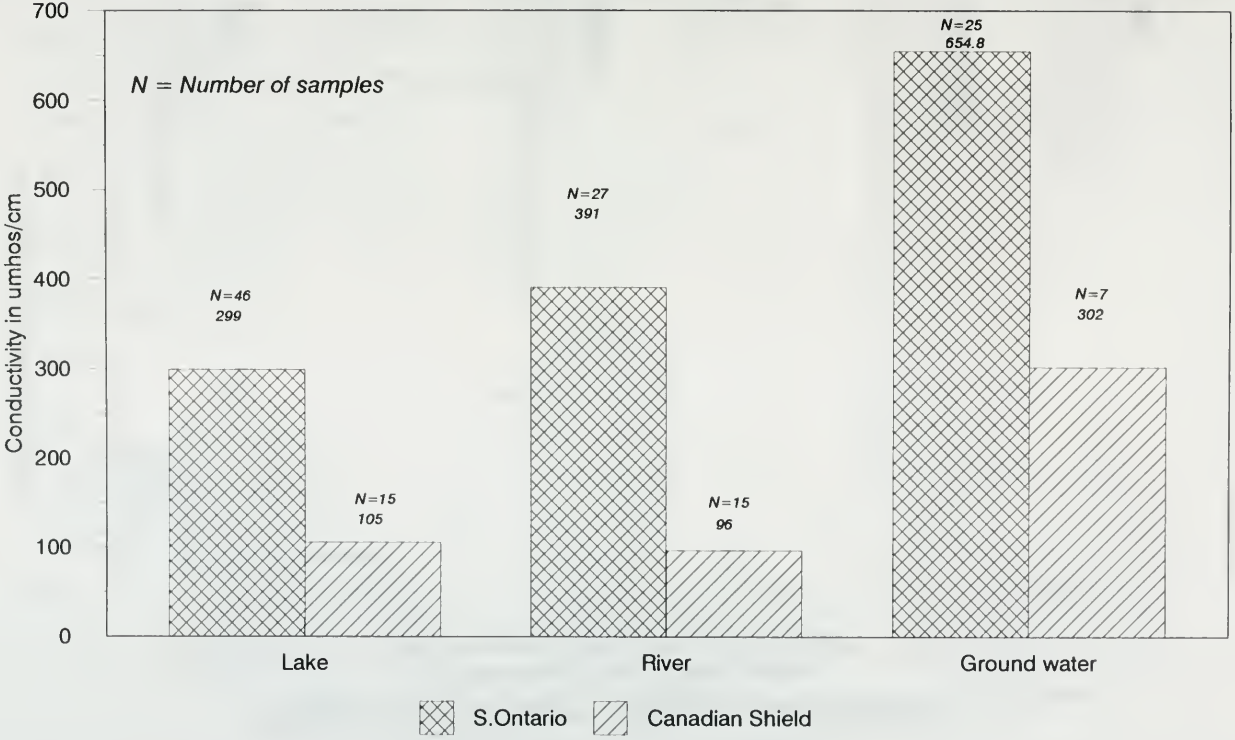


Figure 7.Average Conductivity in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data



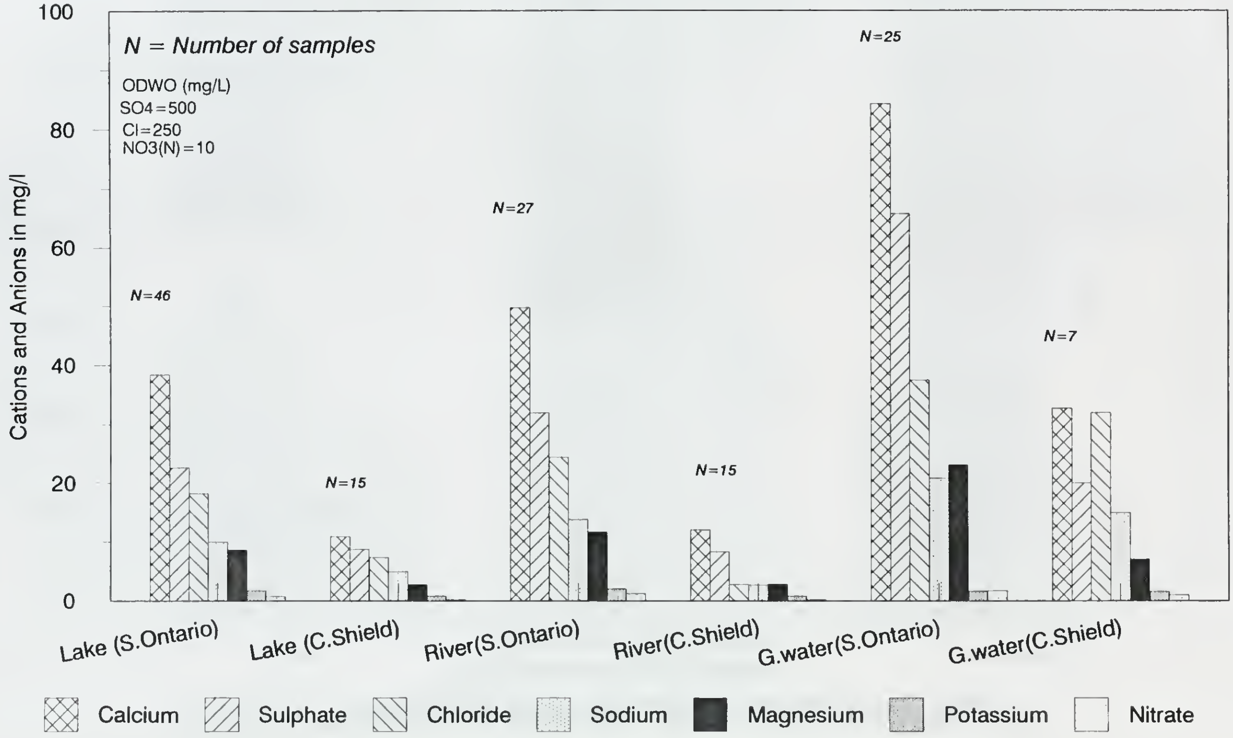


Figure 8. Average Cations and Anions

Concentrations in Source Water used in
Water Treatment Facilities in Ontario from DWSP

Figure 9.Average Alkalinity in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data

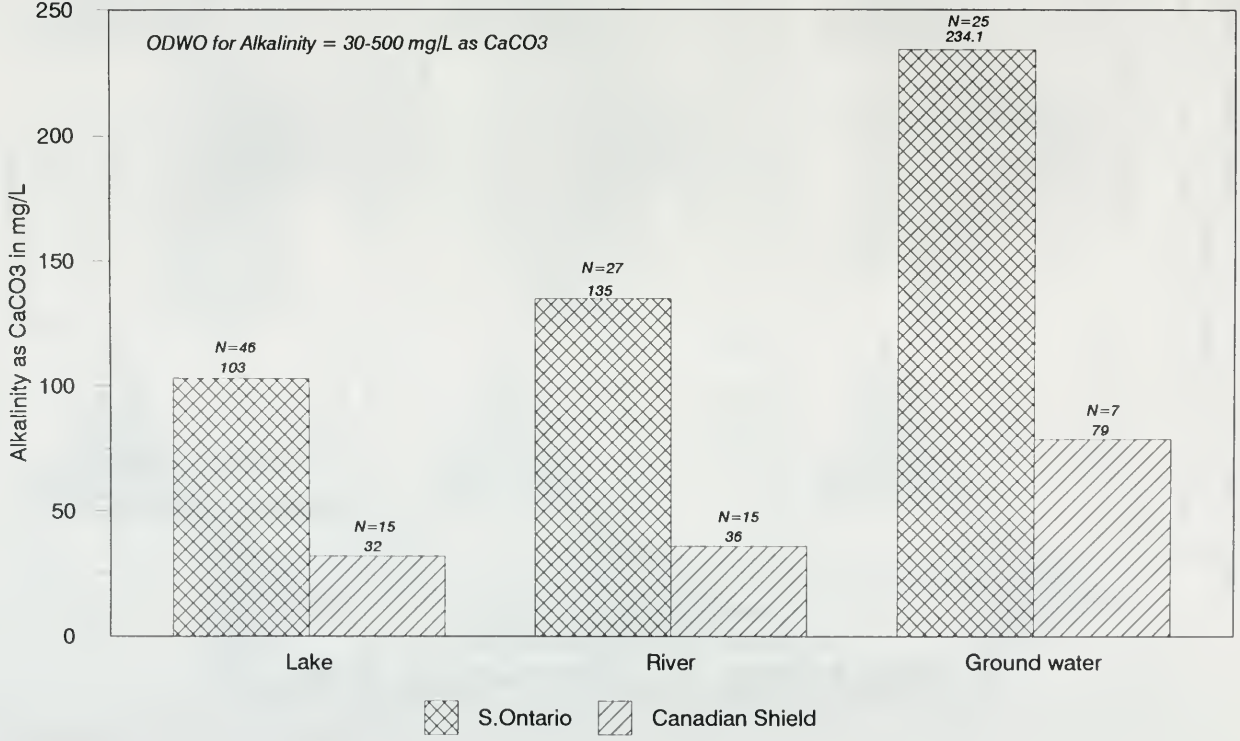


Figure 10. Average pH in Source Water

used in Water Treatment Facilities
in Ontario from the DWSP data

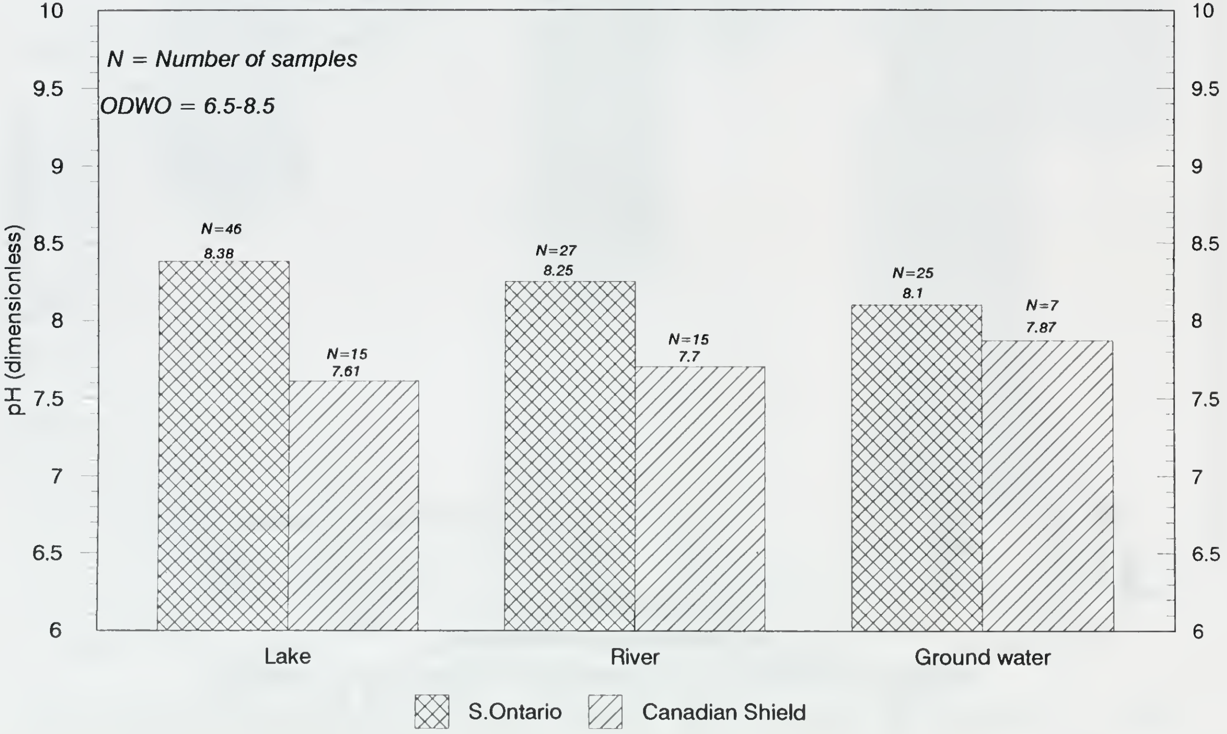


Figure 11. Durov Plots of lake, river and ground water types in Ontario from the DWSP data

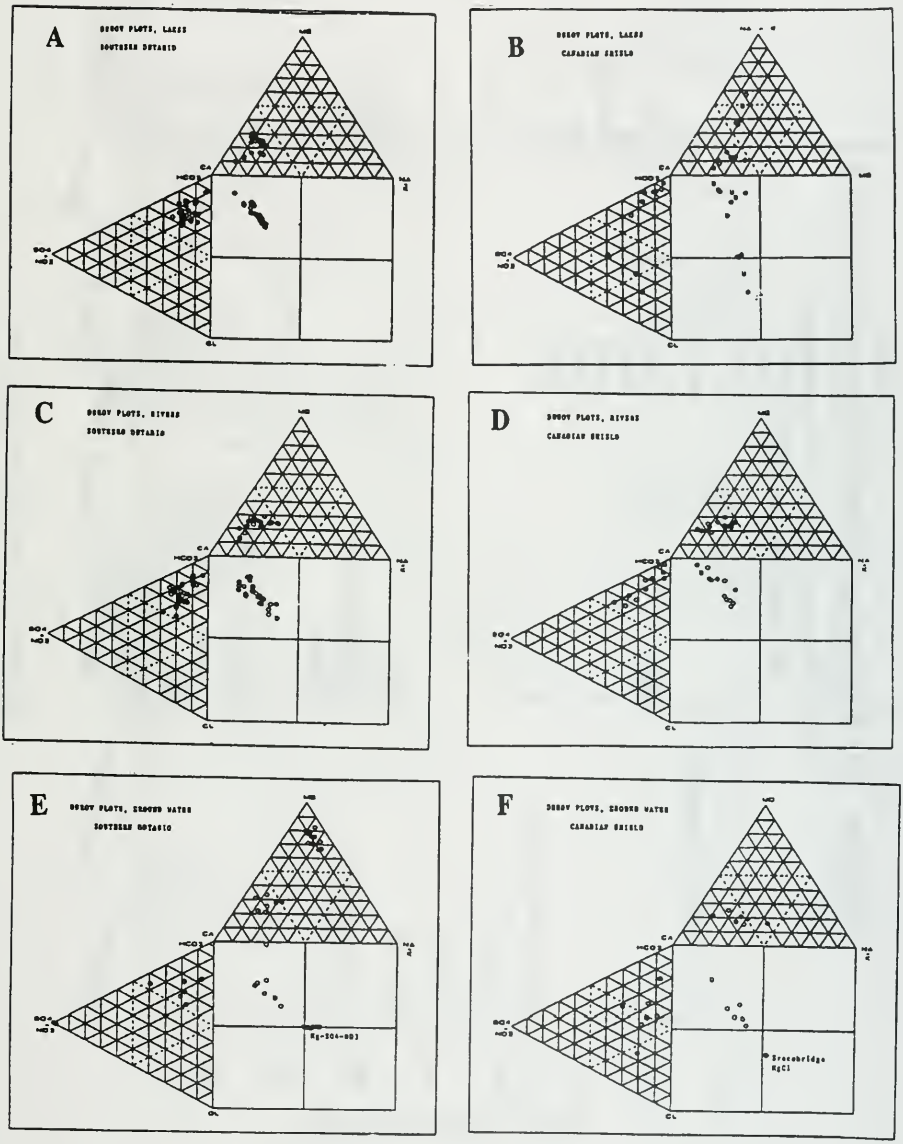


Figure 12. Average Metal Concentrations in
Source Water used in Water Treatment Facilities
in Ontario from the DWSP data

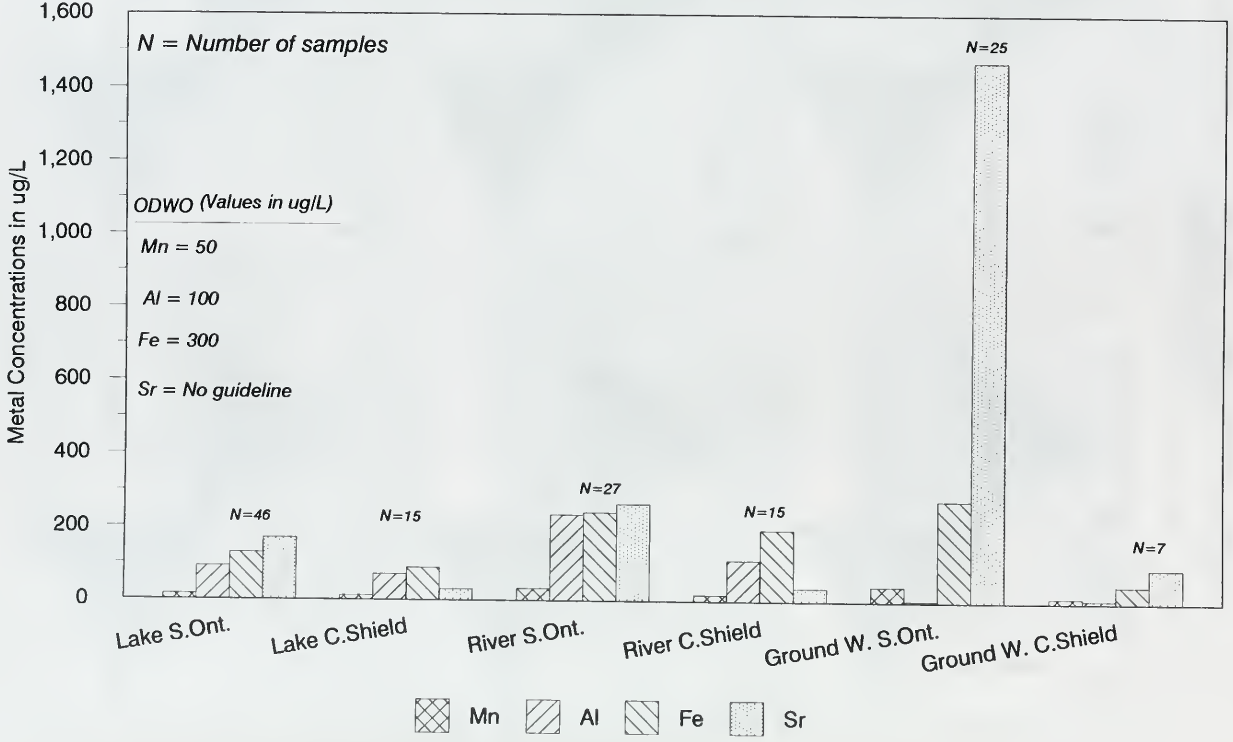
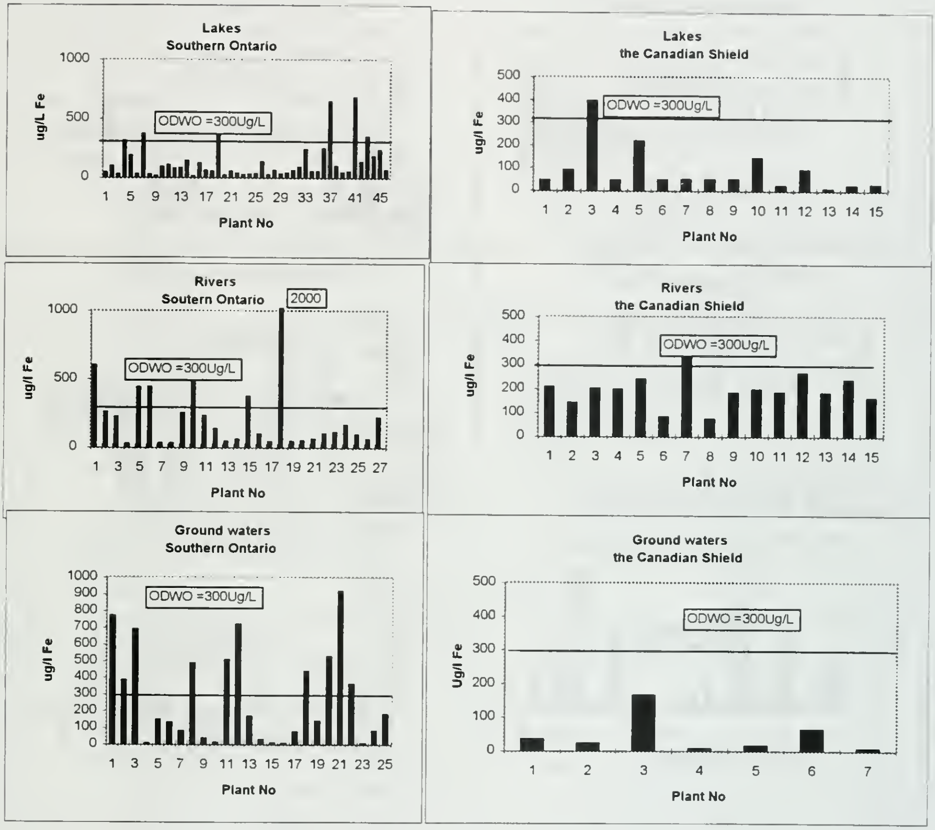


Figure 13. Average Iron concentrations in lakes, rivers and ground water in Ontario from the DWSP data



Lakes Southern Ontario

Lakes the Canadian Shield

Rivers Soutern Ontario

Rivers the Canadian Shield

Ground waters Southern Ontario

Ground waters the Canadian Shield

Figure 14. Average Manganese concentrations in lakes, rivers, and ground waters in Ontario from the DWSP data

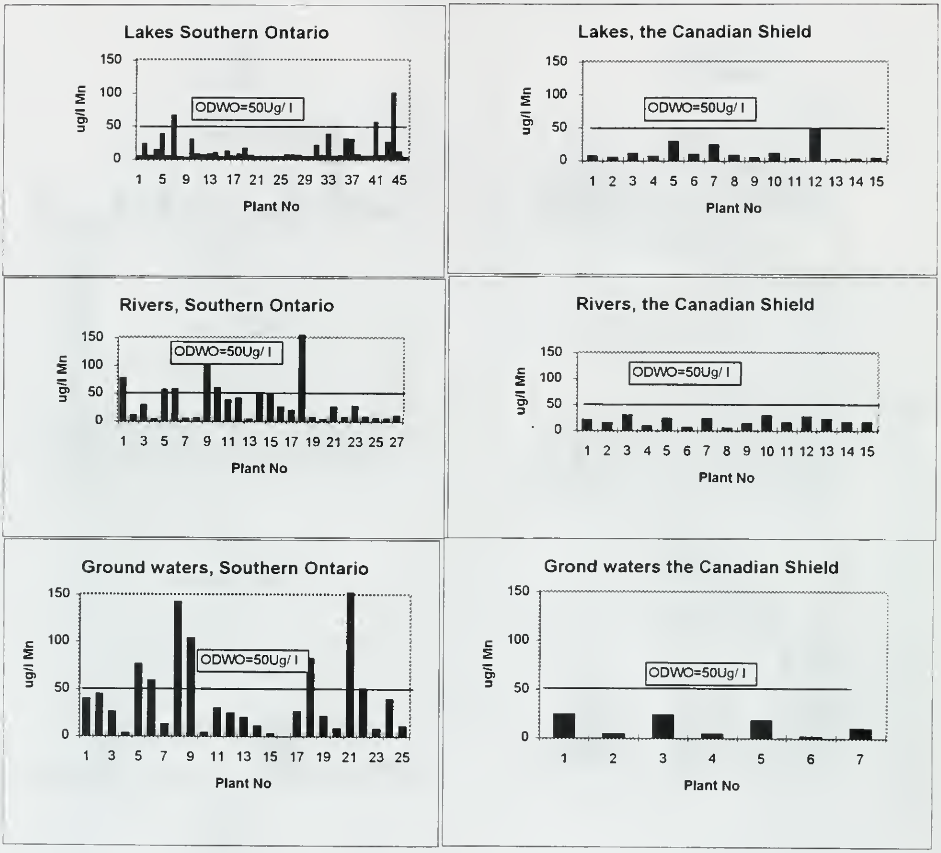


Figure 15. Average Aluminum concentrations in lakes, rivers, and ground waters in Ontario from the DWSP data